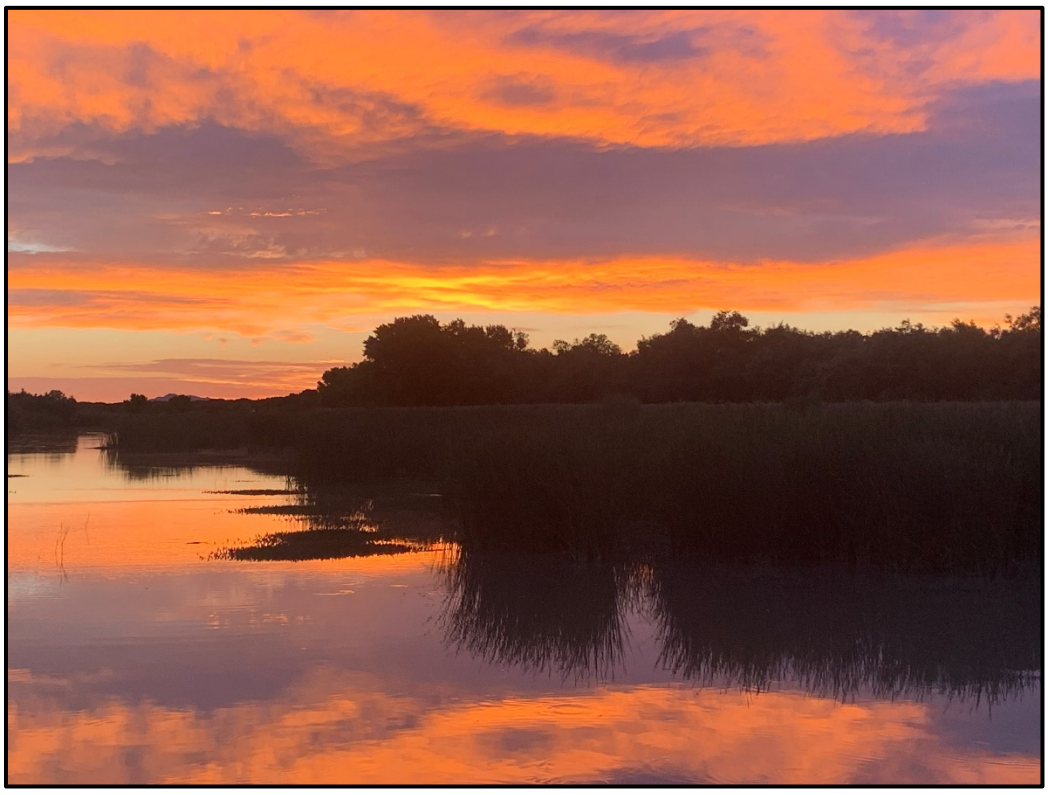
BUREAU OF RECLAMATION

Yellow-billed Cuckoo Study Results - 2019

Middle Rio Grande from San Acacia to Elephant Butte Reservoir, New Mexico

UCB Region



U.S. Department of the Interior

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Yellow-billed Cuckoo Study Results - 2019

Middle Rio Grande from Los Lunas to Elephant Butte Reservoir, New Mexico
UCB Region

prepared by

Technical Service Center
Meghan White, Fisheries Biologist
Dave Moore, Wildlife Biologist
Rebecca Siegle, Natural Resources Specialist

Cover Photo: Rio Grande Low Flow Conveyance Channel in San Marcial 2019. (Reclamation/Meghan White)

Contents

Figures

Tables

Executive Summary

During the summer of 2019, Bureau of Reclamation personnel conducted presence/absence surveys for the Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*) along the Middle Rio Grande of central New Mexico. Surveys were completed within five reaches comprising approximately 82 River Miles from the San Acacia Diversion Dam to the delta of Elephant Butte Reservoir. These surveys were conducted during the cuckoo breeding season (June 15 to August 15), in accordance with established protocols.

A total of 328 Western Yellow-billed Cuckoo detections were recorded during the 2019 breeding season; 75 breeding territories were delineated from these detections. Similar to previous years, the San Marcial Reach contained the largest breeding cuckoo population with 190 detections and an estimated 42 breeding territories, comprising 56 percent of all Western Yellow-billed Cuckoo territories within the study area. The Bosque del Apache Reach contained the second highest number of territories within the study area at 14. Within the San Marcial Reach, the highest density of detections was found within the exposed pool of Elephant Butte Reservoir, which comprised greater than 90 percent of all detections and delineated territories within the reach. The Elephant Butte Reservoir population is the largest in the Rio Grande Basin and one of the largest within the boundaries of the U.S. Fish and Wildlife Service's "Distinct Population Segment", which is the portion of the Yellow-billed Cuckoo population listed as federally threatened under the Endangered Species Act.

Introduction

The Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*), hereafter referred to as YBCU or cuckoo, is a Neotropical migratory bird whose population has been in steep decline due, primarily, to habitat loss and degradation. It is considered a threatened Distinct Population Segment (DPS) under the Endangered Species Act (USFWS 2014b). The Bureau of Reclamation (Reclamation) began formal surveys for the YBCU in the Middle Rio Grande in 2006 and has continued annual surveying and monitoring efforts since that time.

In the southwestern United States, the YBCU nests in large, dense patches of riparian vegetation, particularly with a cottonwood (*Populus deltoides*)/Goodding's willow (*Salix gooddingii*) overstory (Ehrlich et al. 1988, Hughes 1999, USFWS 2014a). A dense understory, comprised of exotic saltcedar (*Tamarix* spp.), Russian olive (*Elaeagnus angustifolia*) or native vegetation (e.g. *Salix* spp.) also appears to be an important requirement for territory establishment (Sechrist et al. 2009). Although saltcedar may be a component of cuckoo habitat, as the proportion of saltcedar increases the overall habitat suitability for cuckoos is believed to decrease (USFWS 2014a). Territories range in size from 4 to 40 hectares (ha), are usually in close proximity to water, and are not defended from conspecifics (Halterman 2001, Sechrist et al. 2013). In New Mexico, home range estimates for YBCUs within the San Marcial Reach of the Middle Rio Grande varied from 5 to 282 ha and averaged 82 ha based on their minimum convex polygon (Sechrist et al. 2009). Nest heights range from 1.3 to 13 meters (m) and the nesting cycle at each nest is very rapid; the time from egg laying to fledging takes approximately 17 days (Halterman 2001, Hughes 1999). In the Southwest, YBCUs typically arrive at breeding grounds by mid-June and initiate migration to wintering grounds in Central and South America by mid-August (Halterman et al. 2000). In 2010, a YBCU from the Middle Rio Grande was confirmed to have overwintered in parts of Paraguay and Northern Argentina using the Pecos River in both its spring and fall migration to and from the Rio Grande (Sechrist et al. 2012).

Figure 1 illustrates the historic and current breeding range of the YBCU. The Rio Grande is considered one of the important strongholds for the YBCU, and historically they were "relatively common" along sections of the river (Howe 1986). In particular, the San Marcial Reach of the Middle Rio Grande continues to retain a large proportion of annual cuckoo detections and is likely an important breeding and source population for the species. During the past 80 years, the population of YBCUs has declined dramatically due to habitat loss and modification as well as a reduction of food resources due to pesticides (Gaines and Laymon 1984, USFWS 2014b). The cuckoo diet primarily consists of large insects including green caterpillars, katydids, and cicadas (Laymon 1998).

It has been debated whether the Western YBCU is a true subspecies of the Yellow-billed Cuckoo. In 2001, the USFWS determined that the western population is a DPS from the eastern population (*C. a. americanus*), with the division being the continental divide from Montana to central Colorado; the eastern boundary of the Rio Grande drainage from central Colorado to Texas; and the mountain ranges that form a southeastern extension of the Rocky Mountains to the Big Bend area in west Texas (USFWS 2009; Figure 2). The USFWS (2001) concluded that the listing of the Western YBCU as endangered was "warranted, but precluded by higher priority listing actions," which was

Figure 1.—Historic and current breeding range of the Western YBCU (adapted from Laymon and Halterman 1987).

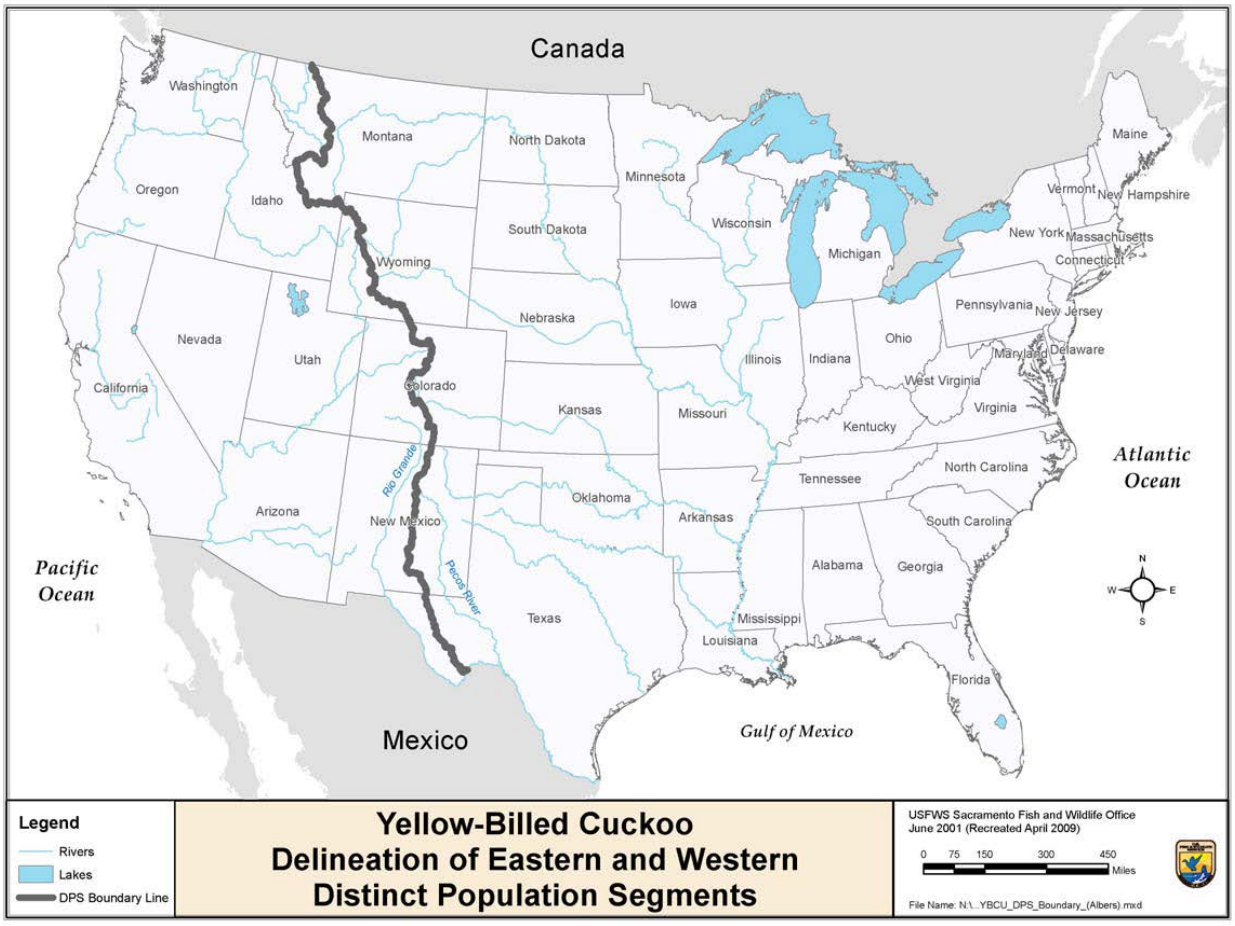


Figure 2.—Delineation of distinct population segments of YBCUs (USFWS 2009).

reaffirmed in 2012 (USFWS 2012). In 2005, the USFWS revised the listing priority of the Western DPS of the YBCU from 6 to a higher priority of 3 to better reflect the fact that threats are imminent to this population (USFWS 2005).

In 2013, the USFWS published a proposed rule to list the Western DPS as threatened under the Endangered Species Act, as amended (USFWS 2013). On November 3, 2014, the Western Yellow-billed Cuckoo's threatened listing became effective under the Endangered Species Act (USFWS 2014b). The species is also listed as threatened, endangered, or sensitive by the states of California, Arizona, New Mexico, Colorado, and Utah.

From 1998 through 2005, Reclamation collected incidental YBCU detection data while conducting Southwestern Willow Flycatcher (*Empidonax traillii extimus;* SWFL) surveys within the Middle Rio Grande. In 2006, Reclamation initiated formal presence/absence surveys along 33 river miles of the Rio Grande to more accurately determine the distribution and abundance of YBCUs. Between 2006 and 2008 there were incremental increases in the size of the area surveyed. An additional 35.5 river miles were added in 2014 between the southern boundary of the Isleta Pueblo and the U.S. Hwy 60 bridge. The survey area within the exposed portion of Elephant Butte Reservoir has slightly increased since 2009, due to developing and maturing habitat within the lower elevations which

reached suitability and warranted formal surveys. From 2006 through 2008, a minimum of three surveys were conducted per breeding season. Since 2009, a minimum of four surveys per breeding season have been conducted.

Additionally, from 2006 through 2008 Reclamation developed and applied a Geographic Information System (GIS)-based model to estimate the number of breeding YBCU territories. In 2009 this method was modified to achieve a more accurate estimation of breeding territories. YBCU detections were grouped based on survey detection results, habitat availability, breeding biology, and best biological opinion. The use of detection groupings is believed to more accurately estimate the number of breeding territories and is very similar to the territory estimation techniques defined in Halterman et al. (2016).

YBCU data collected from 2009 to present are considered comparable since the survey effort and the study area are similar, although annual survey results prior to 2009 are also presented in this report.

In addition to formal YBCU presence/absence surveys conducted annually since 2006, Reclamation has simultaneously conducted several other cuckoo studies. The following is a brief description of these studies and the associated reports/manuscripts where more in-depth information can be found:

- During the summers of 2007 and 2008, 13 cuckoos within the Middle Rio Grande Study Area were captured and affixed with radio transmitters in an effort to determine daily and seasonal movements, and to estimate the extent of home ranges and habitat use. For additional information on this study, see Sechrist et al. (2009).

- The radio telemetry program was reinitiated and expanded in 2017 to acquire data on nest site selection and reproductive parameters. Eight cuckoos were captured and affixed with radio transmitters within the Elephant Butte Reservoir Delta. Two instrumented birds provided usable movement data and three nests were located and monitored. In 2018, 11 cuckoos were captured and affixed with radio transmitters between River Mile 48 and Monticello Bay. Nine instrumented birds provided usable movement data (Dillon and Moore 2019). The 2019 capture area was north of the Bosque del Apache. Twelve cuckoos were captured in 2019 between River Mile 116 (San Acacia Dam) and River Mile 87 (Highway 380) and three nests were monitored. Telemetry data is presented in a separate report (Dillon and Moore 2020). Telemetry studies in the Middle Rio Grande will be continued in forthcoming breeding seasons (alternating between reaches) to gather more comprehensive data on habitat selection, nest site requirements, and reproductive success.

- In 2009, 13 cuckoos within the Middle Rio Grande Study Area were affixed with light-level geolocators in an effort to determine the migration patterns and wintering areas of Western YBCUs. In 2010, one individual was recaptured providing the first ever documentation of the annual migration pattern of a YBCU. The individual appeared to have migrated through the Pecos River basin on both its spring and fall migrations. It over-wintered in parts of Bolivia, Brazil, Paraguay, and Argentina. Its spring migration route differed from its fall route, taking it through portions of the Caribbean. For additional information regarding this study, refer to Sechrist et al. (2012).

- In 2011, four individuals within the Pecos Basin were affixed with light-level geolocators with programmable radio beacons preset to begin transmitting in July 2012. During the summer of 2012, recapture efforts were initiated for these four individuals, and one geolocator was recovered. An additional five individuals were captured during the summer of 2012 and outfitted with geolocators (Sechrist and Best 2012). Efforts to recapture YBCUs originally fitted with geolocators during the 2011 and 2012 seasons were unsuccessful in the summers of 2013-2015. One individual with a visible geolocator was observed on several occasions but was not successfully recaptured. The purpose of this study was to determine whether YBCUs from the Pecos Basin follow similar migration patterns and utilize the same wintering areas as those from the Rio Grande.

- A YBCU habitat suitability model was completed for the Middle Rio Grande in 2018 (Siegle et al. 2018). Vegetation maps produced in 2016 were used to identify habitat types determined to be suitable for YBCU breeding. Suitability criteria included native overstory patches greater than 8 ha in size and 30 m in width that included a Goodding's willow component.

Methods

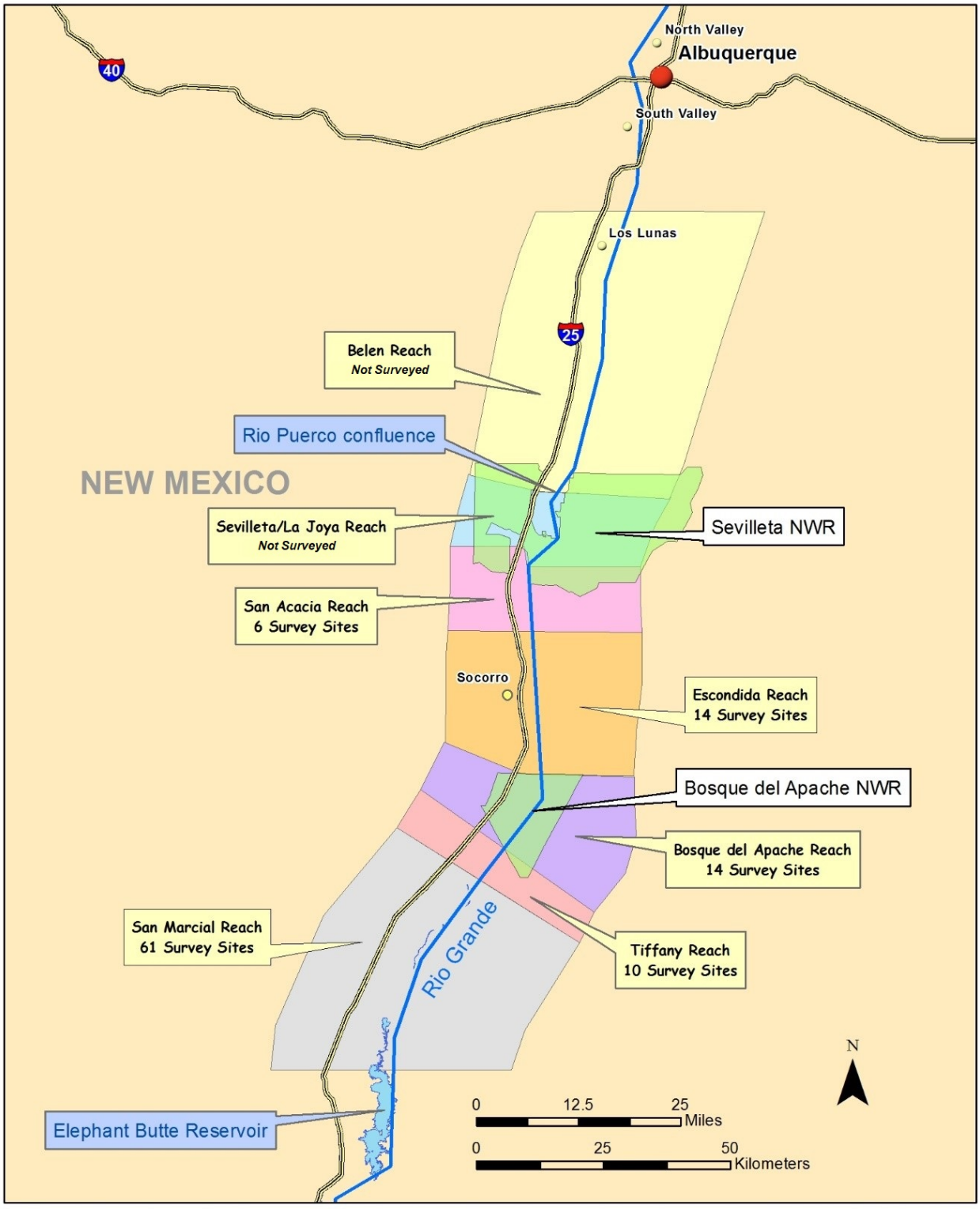
Study Area

In 2019, approximately 79 River Miles of the Rio Grande riparian corridor from the San Acacia Diversion Dam downstream to Elephant Butte Reservoir were surveyed. This area was divided into five river reaches (Figure 3, Table 1). All reaches were subdivided into individual survey sites which were typically sized to be thoroughly surveyed per established protocols by one person in a single day. Most of the sites lie within the active floodplain of the Rio Grande with the exception of the Low Flow Conveyance Channel (LFCC) sites in the San Marcial Reach which lie to the west of the active floodplain. Riparian vegetation dominates most sites and is primarily comprised of native willows and cottonwoods, or exotic saltcedar and Russian olive varying in height, age, and density classes. The following is a reach-by-reach description of the study area from north to south.

Table 1.—River reaches included in the 2019 survey area

River Reach	River Miles (beginning and end points)	Length (river miles)
San Acacia	116.0 to 104.0	12.0
Escondida	104.0 to 84.0	20.0
Bosque del Apache	84.0 to 74.0	10.0
Tiffany	74.0 to 68.5	5.5
San Marcial	68.5 to 37.0	31.5
Total 2019 Survey Area	**116 to 37**	**79 River Miles**

The San Acacia Reach extends downstream approximately 12 river miles from San Acacia Diversion Dam to Escondida Bridge comprising 838 ha of riparian vegetation (Figure 3, Tables 1 and 2). This is a long narrow reach constricted by riverside levees and upland, dominated by a mix of native and exotic vegetation. Typical habitat consists of dense saltcedar and/or Russian olive, with occasional New Mexico olive (*Forestiera pubescens*). There are also several large cottonwood galleries in this reach. Overall, native canopy covers approximately 33 percent of the area, and understory (i.e., vegetation less than 4.6 m in height) without any overstory structure covers approximately 36 percent of the reach (Table 2). Although limited in extent, several patches of higher quality YBCU habitat can be found on lower terraces. Only two percent of vegetation in the reach was determined to be suitable as breeding habitat. Since this reach is immediately downstream of San Acacia Diversion Dam, the river channel is incised and has limited overbank flooding. Nevertheless, high Rio Grande flows in the late spring and early summer of 2017 and 2019 resulted in partial flooding of most sites in this reach. The San Acacia reach was first surveyed in 2009.



* Please note: The length of the survey site reaches from north to south along the Rio Grande are exact, whereas the width from west to east is exaggerated for viewing purposes. Most survey sites are within 1 mile (east or west) of the Rio Grande.

Figure 3.—2019 Middle Rio Grande Study Area.

Table 2.—Major vegetation community types[1] and YBCU habitat suitability[2] within respective river reaches mapped in 2016

	Hectares of Habitat Type per River Reach									
	San Acacia		Escondida		Bosque del Apache		Tiffany		San Marcial	
Riparian Community Type*	**ha**	**%**	**ha**	**%**	**Ha**	**%**	**ha**	**%**	**ha**	**%**
Native Canopy / Native Understory	22	3	14	1	55	5	0	0	161	2
Native Canopy / Mixed Understory	124	15	120	7	225	19	26	2	623	9
Native Canopy / Exotic Understory	85	10	141	8	186	15	212	14	413	6
Mixed Canopy / Native Understory	46	5	16	1	17	1	0	0	23	<1
Mixed Canopy / Mixed Understory	47	6	69	4	111	9	0	0	96	1
Mixed Canopy / Exotic Understory	22	3	58	3	9	<1	21	1	33	<1
Exotic Canopy/ Native Understory	30	4	20	1	11	1	0	0	4	<1
Exotic Canopy/ Mixed Understory	7	1	46	3	19	2	0	0	29	<1
Exotic Canopy / Exotic Understory	29	4	99	6	4	<1	0	0	323	5
Native Canopy/No Understory	40	5	66	4	72	6	55	4	568	8
Mixed Canopy/No Understory	36	4	47	3	15	1	72	5	324	5
Exotic Canopy/No Understory	48	6	99	6	70	6	230	15	872	13
No Canopy/Native Understory	34	4	34	2	52	4	87	6	327	5
No Canopy/Mixed Understory	58	7	234	14	153	13	13	>1	489	7
No Canopy/Exotic Understory	210	25	623	37	208	17	856	54	2468	37
TOTAL Hectares	838		1683		1205	(1205††)	1572	(0†)	6752	(4977†)
Suitable YBCU Habitat	19	2	62	4	426	35	0†	0†	968†	11†

[1]Siegle and Ahlers 2017; Vegetation data based on 2014 aerial photography and 2016 ground truthing/classification using modified Hink and Ohmart (1984) method.

[2]Siegle et al. 2018

*Canopy = vegetation greater than 4.6 m in height; Understory = vegetation less than 4.6 m in height.

†Post-Tiffany fire 2017

††Post-Escondida fire 2016

The Escondida Reach extends 20 river miles downstream from Escondida Bridge to the north boundary of the Bosque del Apache NWR and encompasses 1,683 ha of riparian habitat (Figure 3, Tables 1 and 2). Suitable habitat was identified in four percent of the vegetation within this reach and, similar to the upstream reaches, the higher quality native YBCU habitat is found primarily on low lying terraces. River dynamics in this reach are somewhat limited by the San Acacia Diversion Dam. While lower terraces are subject to periodic flooding, overbank and scouring flows are very infrequent. Overbank flooding occurred in this reach in 2017 for the first time since 2010. However, this was uncharacteristic of current conditions and recent drought and occasional river drying has caused the native habitat to show signs of stress and a decline in suitability. In 2019, more extensive overbank flooding occurred but had receded by the end of the survey season. The drier portions of this reach support sparse, shrubby saltcedar and seep willow (*Baccharis salicifolia)* with an occasional cottonwood overstory. More than 50 percent of this reach lacks an overstory component (Table 2). The Escondida Fire burned approximately 212 ha in the northern end of the reach in June 2016. The Escondida reach was surveyed partially for the first time in 2007 and in its entirety since 2008.

The Bosque del Apache Reach, as defined by this study, lies entirely within the active floodplain of the Bosque del Apache National Wildlife Refuge and is approximately 10 river miles long, encompassing 1,205 ha of riparian habitat (Figure 3, Tables 1 and 2). Several large patches of native riparian habitat are usually flooded during high river flows due to the formation of a sediment plug near River Mile 82. The sediment plug forces river water onto the floodplain and most of this reach was flooded up to two meters deep during periods of high river flow in 2017 and 2019. Conversely, the river within this reach regularly dries during low-flow periods in the summer. These river drying events have caused decreased regeneration of young native vegetation, and complete dieback or increased signs of stress in established vegetation. Currently, work is ongoing to reroute the river channel to the east, bypassing the sediment plug. This will potentially affect habitat within the reach in various undetermined ways. Native-dominated canopy covers 45 percent of the active floodplain within this reach (Table 2), and 35 percent of vegetation provides suitable cuckoo habitat. The remaining habitat in this reach is a mixture of saltcedar, Russian olive, seep willow, *Salix* spp., and cottonwood that lacks the height, vertical structure and/or density that is most attractive to cuckoos. This reach has been surveyed in its entirety since 2007.

The Tiffany Reach extends 5.5 river miles downstream from the south boundary of the Bosque del Apache NWR to the north boundary of Elephant Butte Project Lands (Figure 3, Table 1). Portions of this reach can be inundated during periodic high flow events in the Rio Grande, particularly during periods when sediment plugs were formed. However, this was one of the few reaches that did not experience overbank flooding in 2017 and 2019. Although shorter in length, this reach is wide in comparison to other upstream reaches. The Tiffany Fire was started by lightning on June 26, 2017 and burned 3,723 ha in the Tiffany and San Marcial Reaches. Prior to the 2017 Tiffany Fire, the reach comprised 1,572 ha of riparian habitat; post-fire the reach was considered to be devoid of riparian vegetation (Table 2). The only site surveyed within this reach in 2019 was LF-26; all others were excluded due to lack of potential habitat. Prior to the fire, riparian vegetation within this reach was nearly 70 percent monotypic exotic species, primarily saltcedar (Siegle and Ahlers 2017). Small patches of Russian olive, Goodding's willow, coyote willow and cottonwood could be found in the reach, and 16 percent of riparian vegetation was characterized by a native overstory with understory structure. Nine percent of vegetation was considered suitable for breeding YBCUs. After the fire, no suitable habitat remained. An informal assessment of the damage caused by the fire found that some isolated patches of vegetation remained intact, including native overstory vegetation along the river, but little of that

vegetation appeared to be sufficient to provide suitable cuckoo habitat in the near future. Cuckoo surveys have been conducted in this reach since 2006. During the 2019 season, this reach was again evaluated for the presence of potential YBCU habitat and much of the reach continues to remain non-habitat due to the Tiffany Fire. Only one site, LF-26, was surveyed in 2019.

The San Marcial Reach encompasses the Rio Grande corridor between the San Marcial railroad trestle and the Elephant Butter Reservoir Delta (Figure 1). It contains the most riparian habitat of any reach in the study area (6,752 ha pre-Tiffany fire; 4,977 ha post-fire) and the greatest abundance of suitable YBCU habitat when compared to all other reaches in the study area (Table 2). Suitable habitat comprised 11 percent of vegetation (968 ha) after the fire. The 2017 Tiffany Fire burned much of the area north of the receded pool of Elephant Butte Reservoir in varying degrees of severity, which resulted in several of these northern sites not being surveyed in 2018 (i.e. LF 10-13, LF 27-31, LFCC 05a, 06 and 07) due to lack of potential habitat. Prior to the fire, native-dominated canopy covered 25 percent of the reach, and exotic or mixed native and exotic canopy-dominated areas accounted for about 25 percent of the reach. Nearly half of the riparian vegetation was comprised of understory vegetation with no overstory structure. Upstream of the reservoir, the vegetation within the active floodplain is becoming increasingly decadent and dominated by exotics, converted from vigorous stands of native coyote and Goodding's willow to saltcedar. Vegetation in the upstream portion of the reach and outside the active floodplain consists almost entirely of decadent stands of saltcedar. Overbank flooding is essentially nonexistent due primarily to a degraded river channel. The portion of this reach that lies within the exposed reservoir pool is dominated by native vegetation, particularly to the west of the San Marcial Delta Conveyance Channel, and is typically flooded or wetted by flows from the LFCC outfall in areas between river miles 54 and 61. Overall, the exposed pool of Elephant Butte Reservoir encompasses nearly 1,000 ha of multiple age classes of Goodding's and coyote willow habitat that developed as the reservoir pool receded. Some of these stands continue to provide high quality breeding habitat for both YBCUs and SWFLs. However, much of the native habitat within the upper pool has begun to show signs of stress due to both drought and prolonged flood events, resulting in a reduction in foliage density and subsequently a decline in habitat suitability. This reach has been surveyed annually since 2006. Subtle increases in the extent of surveys within the San Marcial Reach have taken place over the past several years. These increases have occurred within Elephant Butte Reservoir where developing habitat has become suitable as the reservoir pool recedes and additional surveys were warranted. In 2019, increased reservoir storage and overbank flooding inundated several of the survey sites south of River Mile 42 (EB 15 – 17) and levee breaches flooded potions of sites between River Miles 47 and 45 (EB 09 – EB 11).

Presence/Absence Surveys

All reaches were surveyed using methodology as described in "*A Natural History Summary and Survey Protocol for the Western Distinct Population Segment of the Yellow-billed Cuckoo*" by Halterman et al. (2016). To minimize migratory detections, all four surveys were conducted within the YBCU resident period (Table 3) as defined by Halterman et al. (2016) and supported by telemetry results from Sechrist et al. (2009). Therefore, all detections are believed to be those of resident paired or unpaired cuckoos. Multiple surveys were conducted to increase the likelihood of detection, increase the probability of detecting late arrivals, and indicate which sites remained occupied throughout the breeding season.

Beginning in 2009, surveys were conducted four times per breeding season with a minimum of 12 days between surveys, and generally between 05:30 and 11:00 a.m. (depending on weather conditions). General dates for each survey period are summarized in Table 3.

Table 3.—YBCU survey periods

Survey number	Survey period
1	June 15th to June 30th
2 & 3*	July 1st to July 31st
4	August 1st to August 15th

* Mid-season start and end dates can be +/- three days.

Prior to conducting formal surveys, all surveyors are required to attend formal protocol training. Surveyors use the repeated call-playback method throughout all suitable habitat in their designated survey site. At each playback location, the prerecorded "*kowlp*" call is broadcast using a wireless speaker for 20 to 30 seconds, with a one-minute pause to allow detection of a YBCU response. This procedure is repeated five times, or until a YBCU response is detected. If no response is detected, surveyors move 100 m to the next playback station, repeating the call/pause sequence. If a response is heard, the observer stops playback, records their observations, and moves 300 m before repeating the procedure, in order to reduce the potential of duplicate counting of individuals for each respective survey. This technique is also intended to maximize the detectability of individuals throughout the breeding season.

For the purpose of this report, a single detection is defined as the documented presence of a YBCU during a survey. A single individual may have multiple detections over the season. For example, an individual YBCU documented during each of the four surveys would constitute four detections, while an individual only documented on one survey would be a single detection. Survey data were recorded on field forms which were subsequently transferred to electronic survey forms developed by Reclamation, as well as an Excel spreadsheet and GIS database. The actual location of the detected cuckoo was derived from the surveyor's location, the compass bearing to the detected YBCU, and an estimated distance.

Data recorded when a YBCU was detected included the following:

- Detection time
- Detection type (aural, visual, or both)
- Call type ("*kowlp*", "*knocker*", or "*coo*")
- Playback number at time of detection
- UTM (NAD83) coordinates of the surveyor, and estimated bearing and distance to YBCU
- GPS accuracy when detected YBCU waypoint was taken
- Relevant comments (e.g. observed breeding activity, vegetation types, hydrology, etc.)

Territory Estimation

A breeding territory is loosely defined as a breeding unit of YBCUs, generally comprised of a male and female, but may also include a helper male. In the absence of breeding behavior or nest confirmation, YBCU detection data becomes the primary source of territory estimation data. There are a number of difficulties in determining the number of territories, which include:

1) Breeding territories can be comprised of two to three adults (Halterman, pers. comm. 2008).

2) Both males and females vocalize – making "kowlp, "knocker" or "coo" calls - and therefore cannot be differentiated by call.

3) YBCUs have large, undefended territories and can travel >500 m/day or >3,000 m during the breeding season, based on telemetry data (Sechrist et al. 2009).

4) YBCU territories can overlap since they are undefended, allowing for habitat use by multiple breeding pairs of YBCUs.

5) Actual YBCU locations are calculated based on surveyor UTMs, distance, and compass bearing, all of which have inherent estimation errors.

6) Surveys conducted later in the breeding season (i.e. Surveys 3 and 4) could detect hatch year fledglings that have dispersed from the nest site into surrounding areas; resulting in an overestimation of breeding pairs based on detections.

Prior to 2009, a standardized technique developed by Reclamation was used to estimate territories by grouping YBCU detections into fixed 500 m radii using GIS analysis (Johanson et al. 2008). This technique allowed for a consistent and repeatable estimation of YBCU territories but tended to overestimate the abundance of YBCU territories when detections were widely scattered and underestimate them when detections were relatively dense.

Realizing the inherent errors in the previous method, the following rules have been used since 2009 to estimate the number of breeding YBCU territories:

1) All YBCU detections are considered to be those of resident birds.

2) A YBCU territory MUST have a minimum of 2 detections <500 m apart during at least 2 of the 4 total surveys (Example 1, Figure 4). If these conditions are not met, the detections are not considered as part of a breeding territory, but rather as random/floater detections.

3) No more than 3 detections within 300 m, during the same survey period, can be included within a single YBCU territory. More than 3 YBCU detections during the same survey period in an area <300 m suggests multiple breeding territories (Example 2, Figure 4).

4) YBCU clumping patterns should be evaluated based on the number and proximity of detections during individual survey periods. Ideally, multiple discreet detections within 300 m of each other over multiple surveys are needed to confirm a breeding territory (Example 3, Figure 4).

5) Although YBCU territories can overlap, "natural breaks" between detection clumps, regardless of distance, should be considered when delineating territories (Example 4, Figure 4).

6) "Best biological judgment" should prevail when delineating and estimating YBCU territories. Habitat suitability and abundance, as well as the distribution of YBCU detections over the entire breeding season should be considered when delineating breeding territories.

Once the number of breeding territories is estimated, they are categorized as possibly breeding (PO) if there are two or more detections in an area in two survey periods, and probable breeding (PR) if there are three or more detections in at least three survey periods or with single observations of nest building or pair activity. Territories are categorized as confirmed breeding (CO) if there are observations of copulation, nest activity or fledging (Halterman et al. 2016).

Territory center points for each territory are determined based on detection groupings, distribution, and best biological judgement. These center points are used to generate a GIS layer to estimate habitat utilization.

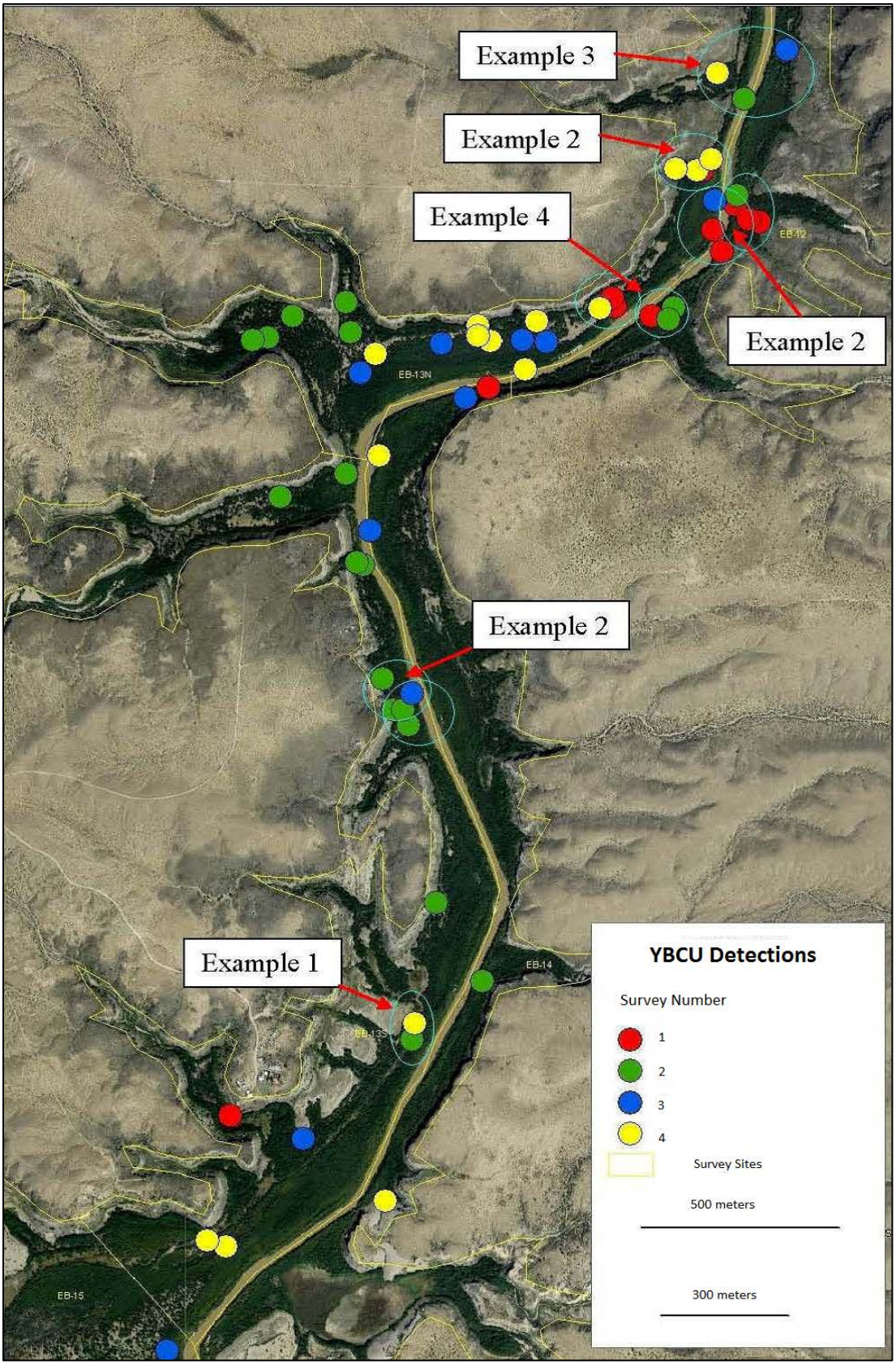


Figure 4.—Examples of YBCU territory estimations.

Habitat Utilization

The study area was first mapped and delineated into Hink and Ohmart (1984) habitat types in the summer of 2012, and this mapping effort was repeated in the summer of 2016 (Siegle and Ahlers 2017). Two analytical methods were used to quantify YBCU habitat utilization and identify potential habitat preferences (Siegle et al. 2018). The first was based on the major habitat community type within which each individual was detected, while the second was based on the habitat encompassing their core use area (i.e. home range or territory center). Delineated Hink and Ohmart (1984) habitat types were grouped into major vegetation community classes (Table 2). Only woody vegetation comprised of native and/or exotic species was included in habitat mapping, and categories such as marsh, open water, road, railroad and upland were considered non-habitat for breeding. Major vegetation community types were delineated based on their canopy (woody vegetation taller than 4.6 m) and understory vegetation (woody vegetation shorter than 4.6 m). The two methods used to determine habitat utilization include:

1) *Detection distribution*
   The location of all cuckoo detections and their associated habitat types were used to assess habitat use in general. Using GIS, the detection points were overlaid onto the major plant community layer to determine which types of habitat were occupied. The distribution of detection points within the major community types was then analyzed. These points and associated habitat types were evaluated to determine habitat use at the time of the detection. An example from the 2018 YBCU survey season is shown in Figure 5.

2) *Territory composition*
   Core use areas were determined by establishing a 150 m radius circle (7 ha) around the territory center point, which is approximately the 50 percent kernel home range determined by a 2-year radio telemetry study conducted in the Middle Rio Grande Study Area (Sechrist et al. 2009). The major vegetation community types utilized by cuckoos in core use areas were determined by calculating the percent area each community type occupied within the 150 m radius circle. An example of this method for evaluating cuckoo habitat use is also shown in Figure 5.

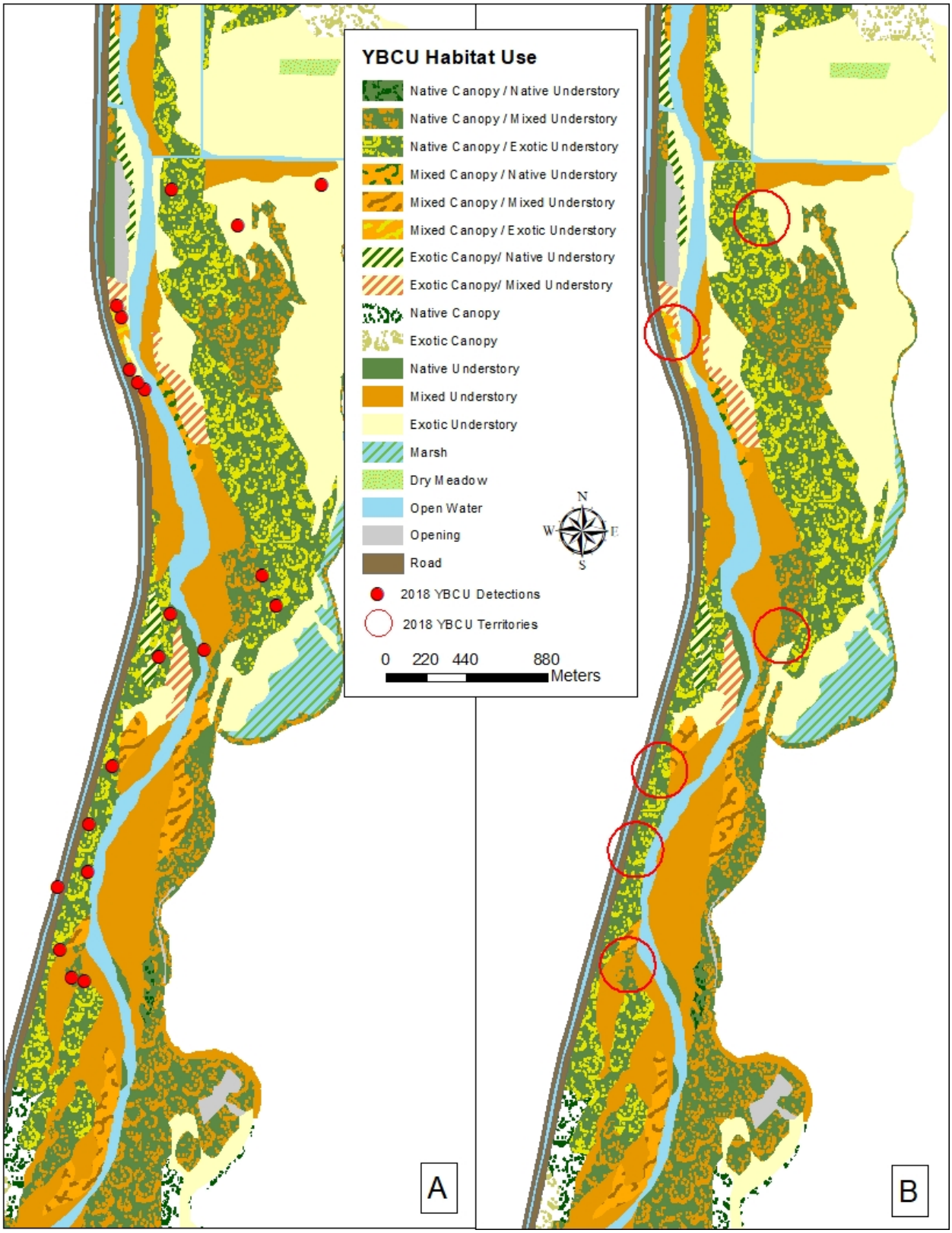


Figure 5.—Illustration showing methods used to quantify habitat use based on YBCU detections (A) and territories (B).

Results

Presence/Absence Surveys

During the 2019 breeding season, 328 YBCU detections were recorded within the Middle Rio Grande study area. Detections were believed to represent approximately 75 breeding territories. Table 4 summarizes the 2019 YBCU detections and estimated territories within each of the 5 river reaches of the 2019 study area.

Overall, YBCU survey results continue to show that the majority of detections and territories were found within the San Marcial Reach (58 and 56 percent, respectively), particularly sites south of LF-17a in the exposed pool of Elephant Butte Reservoir. The Bosque del Apache Reach supported the highest number of territories (n = 14) outside the San Marcial Reach (Table 4). No YBCUs were detected within the Tiffany Reach. However, only site LF-26 was surveyed in this Reach in 2019 due to the Tiffany Fire.

Table 4.—Number and percentage of 2019 YBCU detections and territories by river reach

River Reach	YBCU Detections		YBCU Territories	
	Number of Detections	Percent of Total Detections	Number of Territories	Percent of Total Territories
San Acacia Reach (Figure 8)	29	8.8%	8	10.6%
Escondida Reach (Figure 9)	50	15.2%	11	14.7%
Bosque del Apache Reach (Figure 10)	59	18.0%	14	18.7%
Tiffany Reach (Figure 11)	0	0%	0	0%
San Marcial Reach (Figures 12-15)	190	58.0%	42	56.0%
Totals	**328**	**100%**	**75**	**100%**
Elephant Butte Reservoir (Subset of San Marcial Reach)	186	56.7%	41	54.7%

Figures 6 and 7 graphically represent the distribution of 2019 YBCU detections and territories, while Figures 8 through 15 illustrate the distribution and abundance of 2019 YBCU detections and territories throughout the study area. Survey forms and maps for all survey sites can be found in the Appendix to this report.

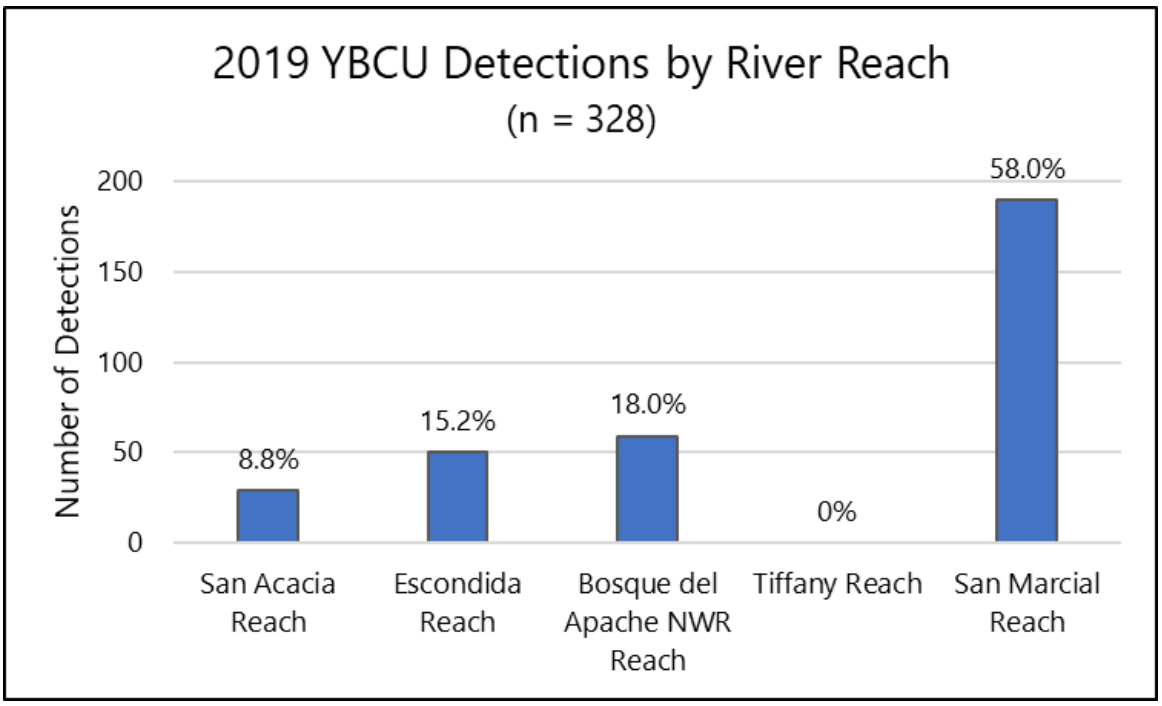


Figure 6.—Number and percentage of YBCU detections by river reach in 2019.

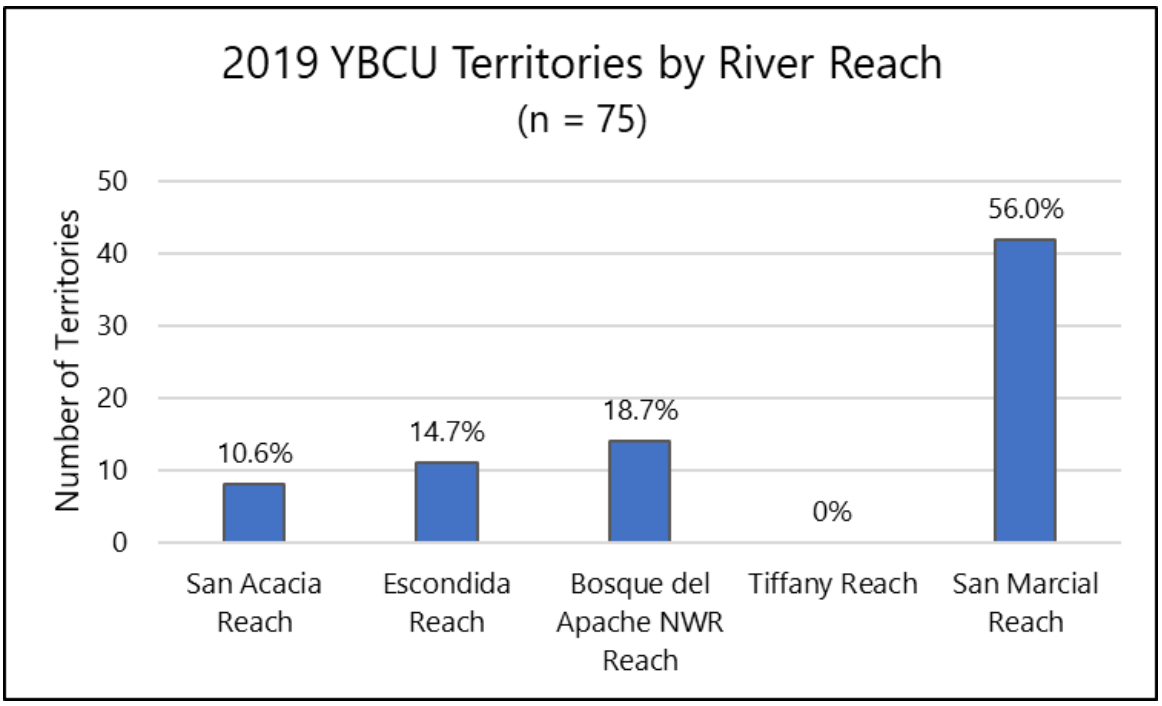


Figure 7.—Number and percentage of YBCU territories by river reach in 2019.

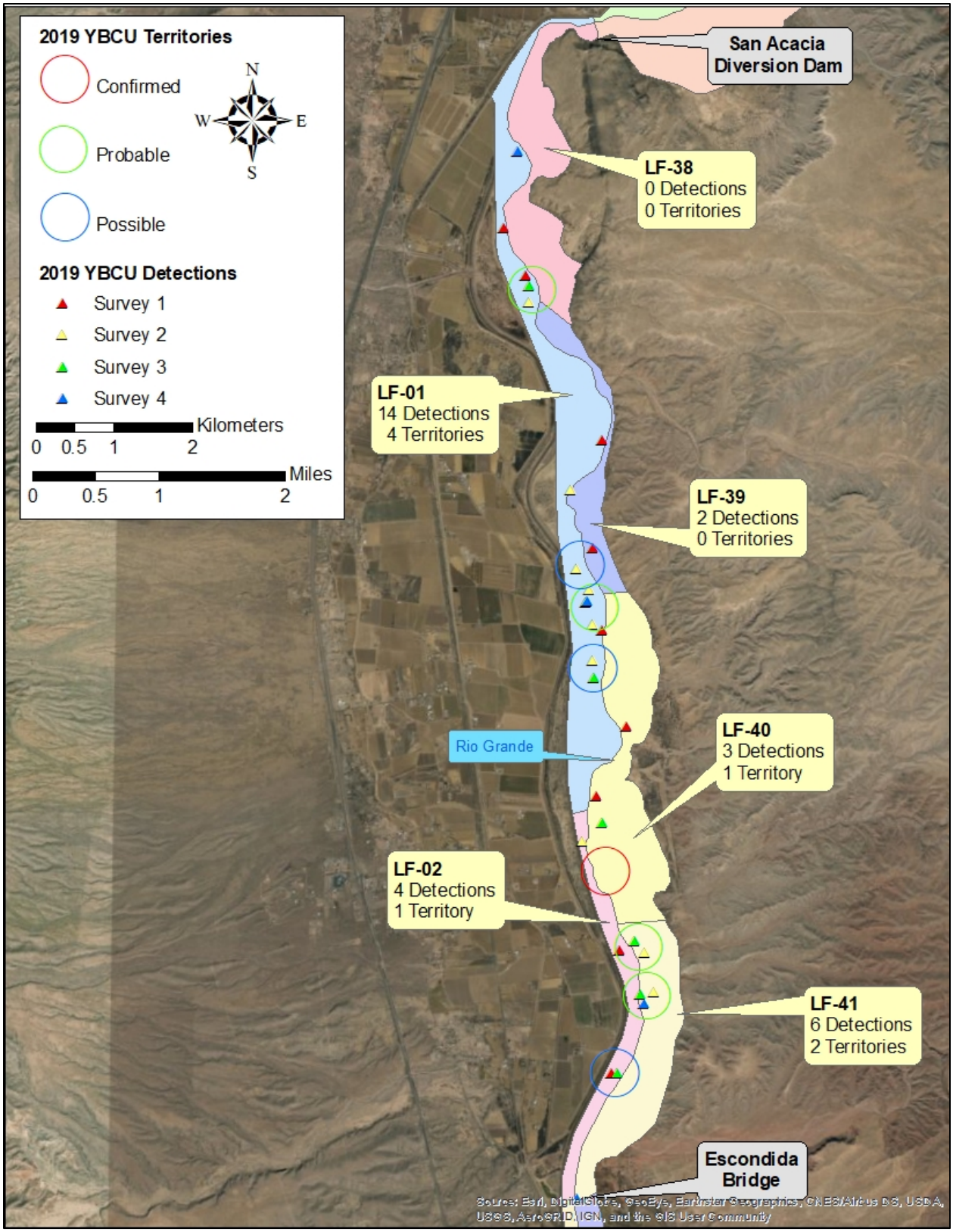


Figure 8.—Overview of 2019 survey sites and YBCU detections within the San Acacia Reach.

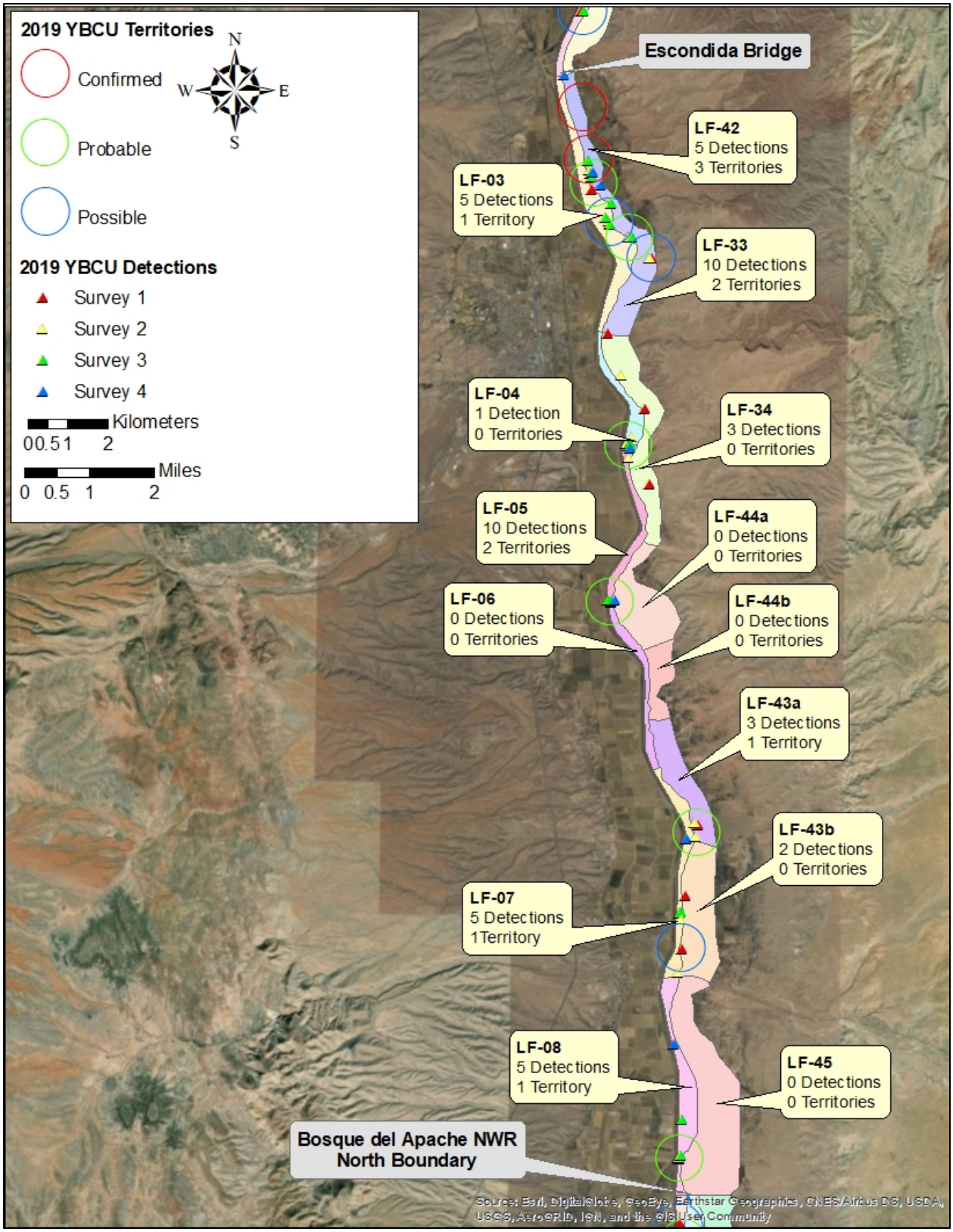


Figure 9.—Overview of 2019 survey sites and YBCU detections within the Escondida Reach.

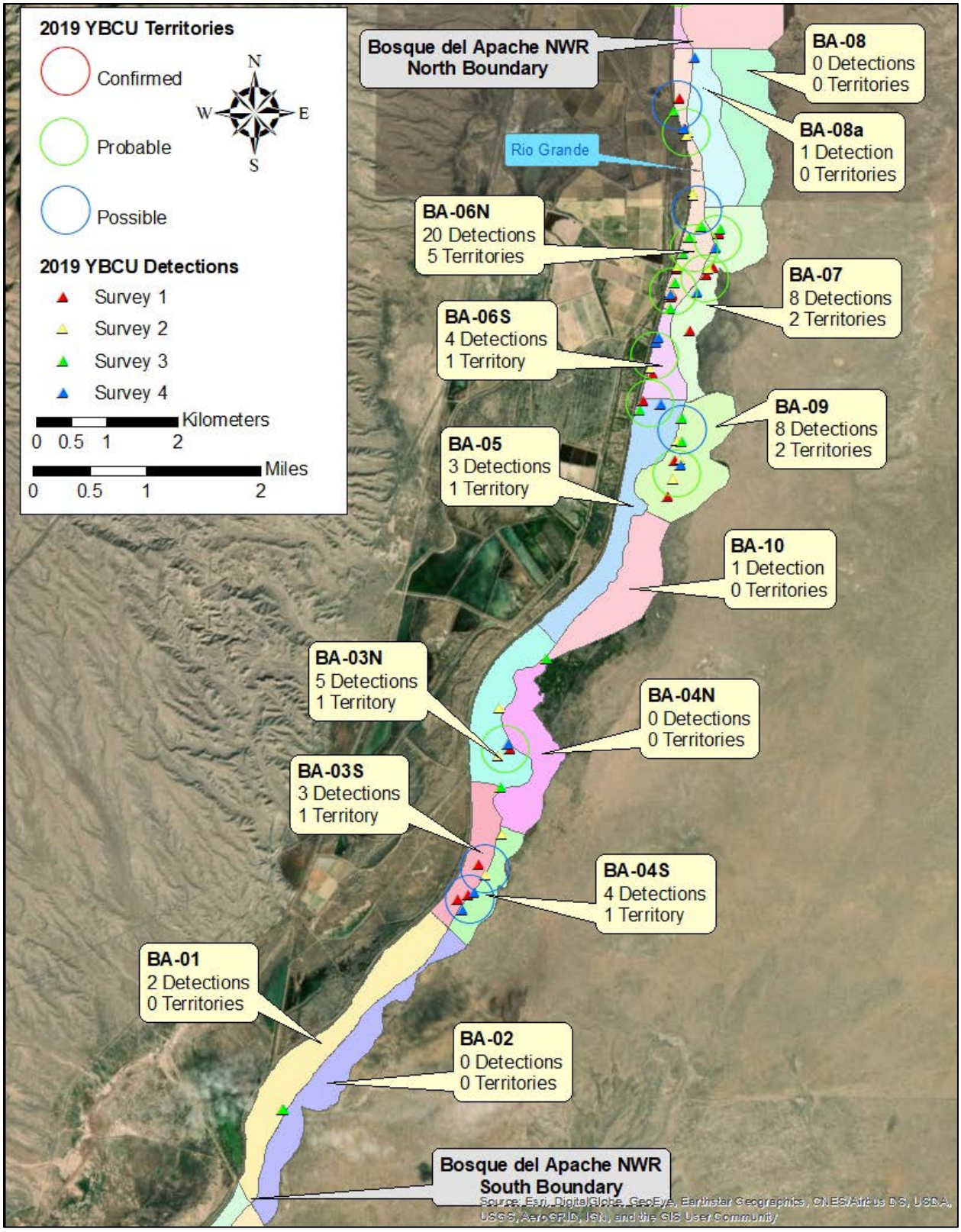


Figure 10.—Overview of 2019 survey sites and YBCU detections within the Bosque del Apache Reach.

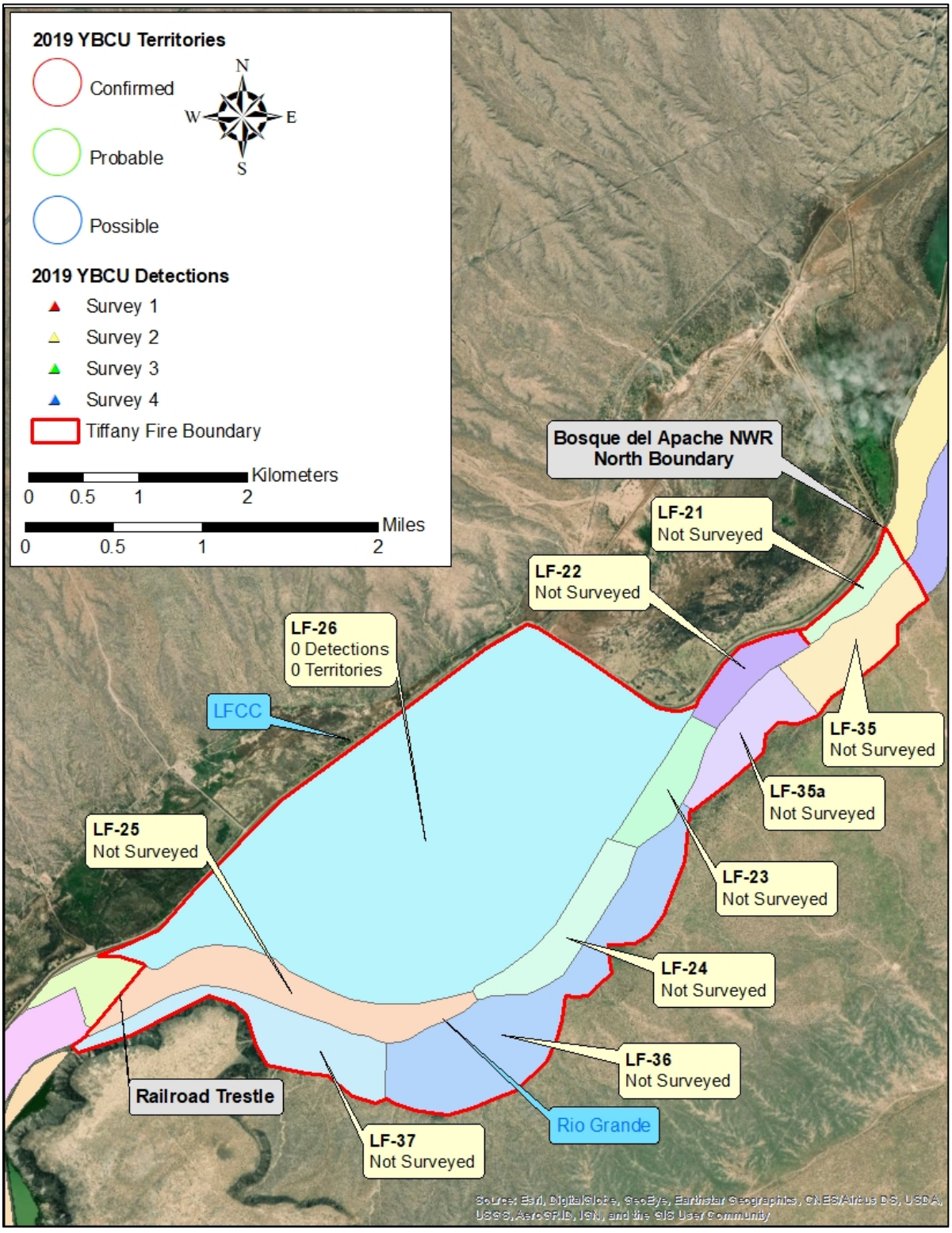


Figure 11.—Overview of 2019 survey sites and YBCU detections within the Tiffany Reach. Boundaries of the Tiffany Fire within this reach outlined in red.

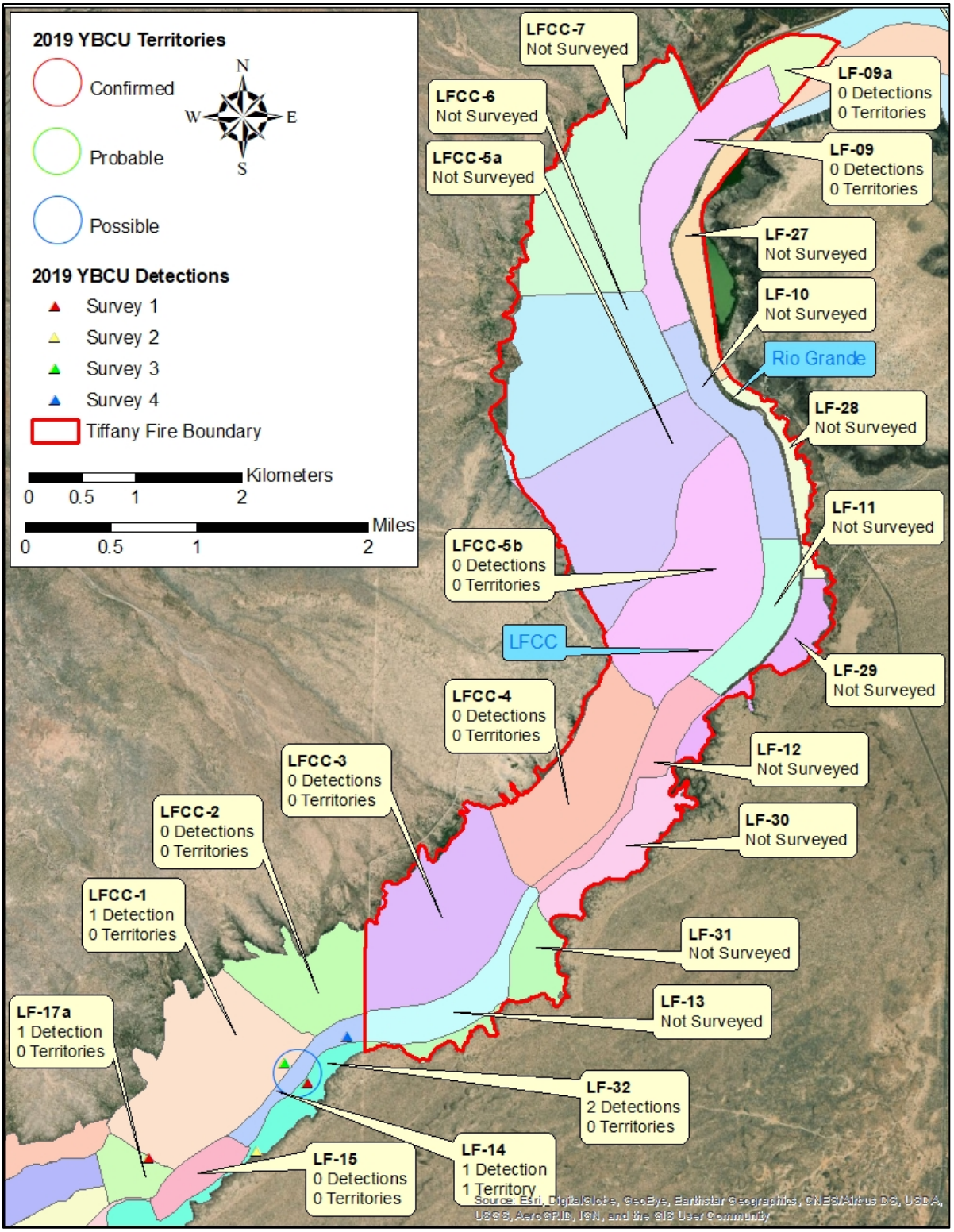


Figure 12.—Overview of 2019 survey sites and YBCU detections within the San Marcial Reach (1 of 4). Boundaries of the Tiffany Fire within this reach outlined in red.

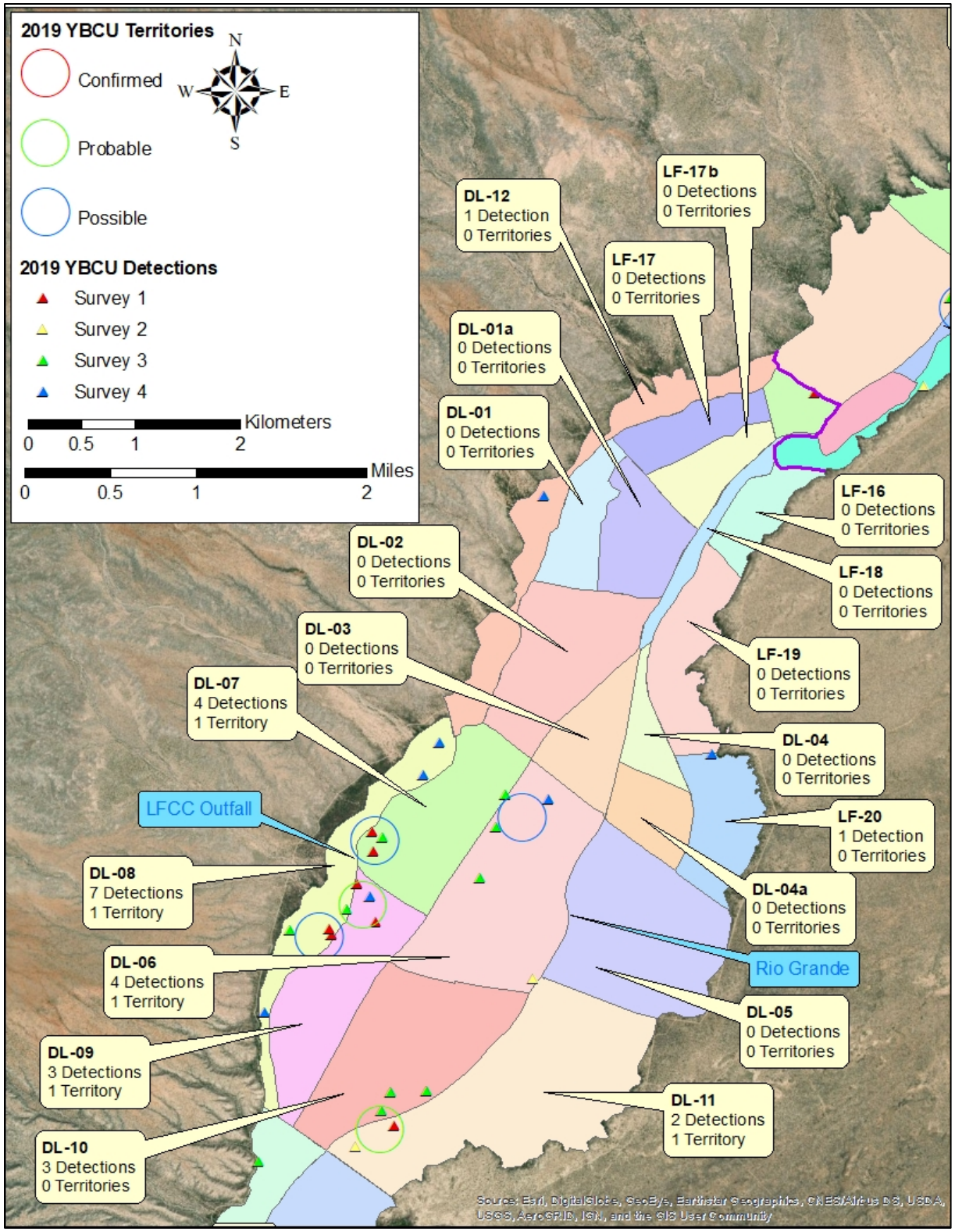


Figure 13.—Overview of 2019 survey sites and YBCU detections within the San Marcial Reach (2 of 4). Purple line delineates northern border of Elephant Butte subset of San Marcial Reach.

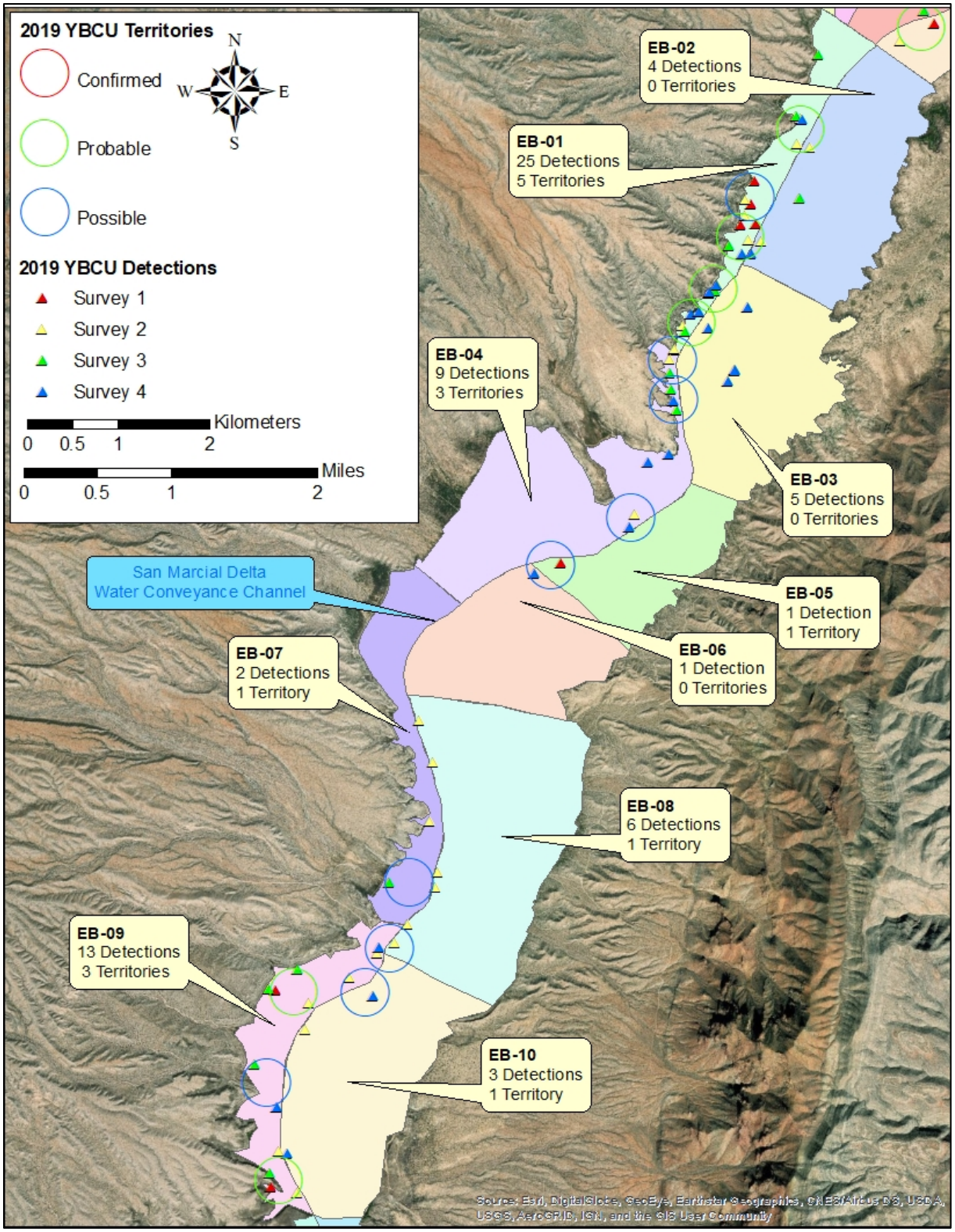


Figure 14.—Overview of 2019 survey sites and YBCU detections within the San Marcial Reach (3 of 4).

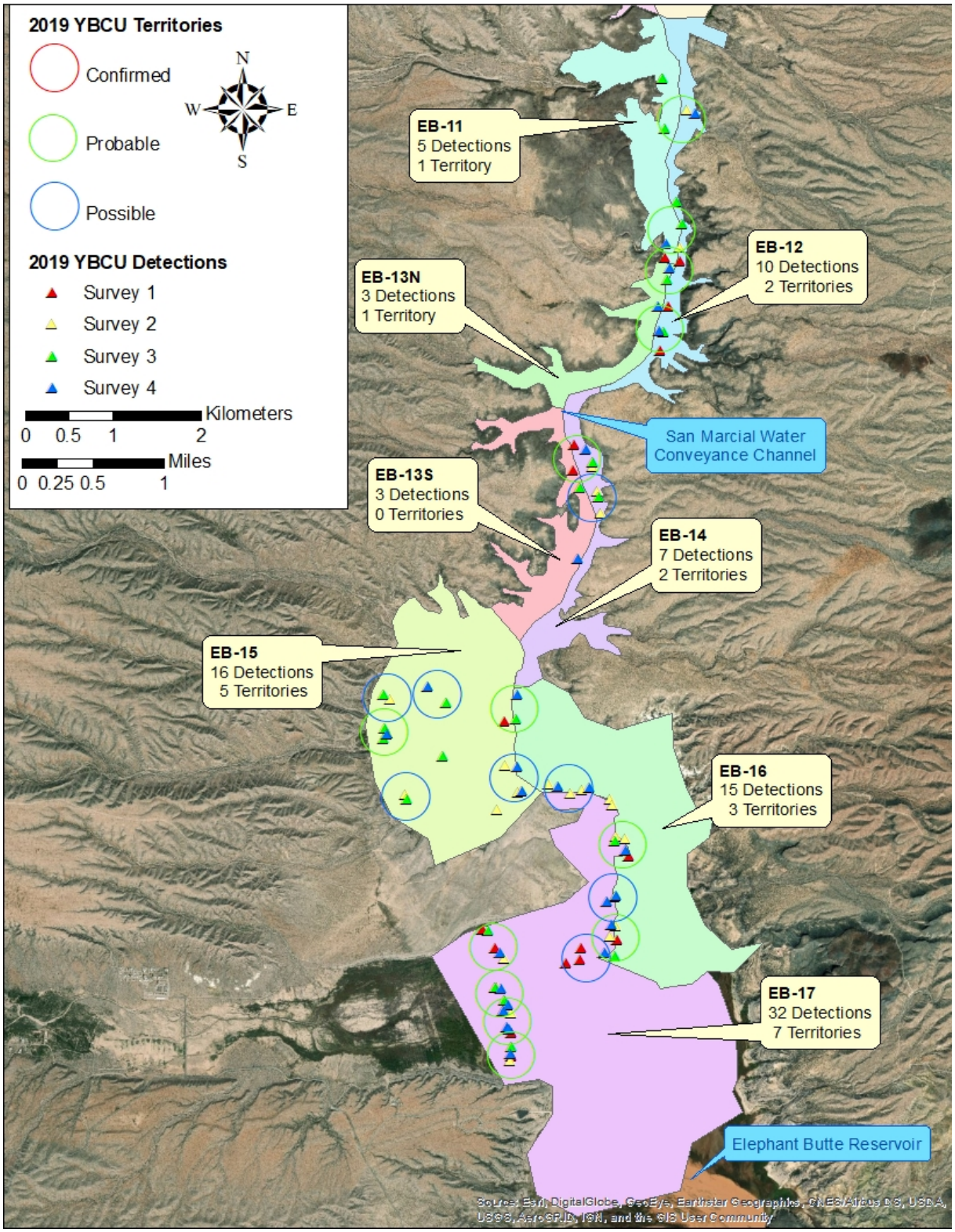


Figure 15.—Overview of 2019 survey sites and YBCU detections within the San Marcial Reach (4 of 4).

Habitat Utilization

Detection Distribution Model

Of the 328 total cuckoo detections documented during the 2019 surveys, 310 were recorded in various habitat types consisting of woody riparian vegetation. Eighteen detections were recorded in areas classified as "non-habitat" (e.g. open areas, cattail marsh, etc.) and were excluded from analysis. For purposes of this analysis, detections that fell within non-habitat but were within 25 m of a plant community type, were classified as that community type instead of non-habitat. This approach accounts for margin of error in identifying exact locations using the assumption that birds were more likely to be responding from within the riparian vegetation than non-habitat types, like the river channel. Table 5 summarizes these detections and their associated major habitat types. Fifty-three percent of the 2019 detections were located in areas with a native canopy component (Figure 16). Additionally, 75 percent of detections were located in habitat with a canopy component and 84 percent included an understory component. [It is important to note that the Hink and Ohmart (1984) classification system defines understory as woody vegetation less than 4.6 m (15 feet) in height.] Approximately four percent of detections were located in habitat dominated by exotic canopy and 25 percent of detections were located in habitat lacking any canopy, 7 percent of all detections were located in exotic understory (primarily saltcedar) without any canopy. Seventy-three percent of detections were in a vegetation community with an exotic component (exotic layer or mixed), and 90 percent contained a native component (including native layers and mixed) (Table 5).

Table 5.—Distribution of 2019 YBCU detections within the major habitat types

Major Plant Community Type	Number of YBCU Detections*	Percent Distribution
Native Canopy/Native Understory	39	12.6%
Native Canopy/Exotic Understory	37	11.9%
Native Canopy/Mixed Understory	63	20.3%
Exotic Canopy/Native Understory	3	1.0%
Exotic Canopy/Exotic Understory	4	1.3%
Exotic Canopy/Mixed Understory	1	0.3%
Mixed Canopy/Native Understory	8	2.6%
Mixed Canopy/Exotic Understory	12	3.9%
Mixed Canopy/Mixed Understory	17	5.5%
Native Canopy – No Understory	25	8.0%
Exotic Canopy – No Understory	4	1.3%
Mixed Canopy – No Understory	20	6.5%
Native Understory – No Canopy	20	6.4%
Exotic Understory – No Canopy	23	7.4%
Mixed Understory – No Canopy	34	11.0%
TOTAL	**310**	**100%**

* YBCU detections within non-habitat areas were excluded (n=18). For purposes of this analysis, if detections fell within non-habitat types but were within 25 m of a habitat type, they were considered to be located in that habitat type, not non-habitat.

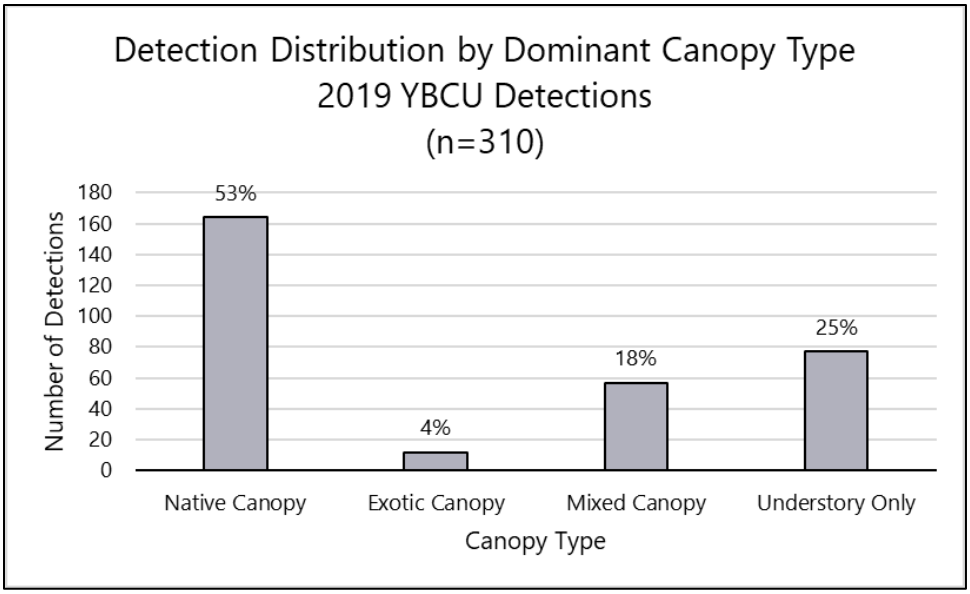


Figure 16.—2019 YBCU detection distribution by dominant canopy type (18 detections in non-habitat areas excluded).

Territory Composition Model

A total of 529.7 ha within the 75 territories delineated were included in the habitat utilization analysis (i.e. ~7.1 ha/territory). Both woody vegetation types and non-habitat types (categorized broadly as open, open water/marsh, and upland) are included in Table 6. A comparison of the habitat composition of delineated cuckoo territories and individual cuckoo detections reveals similar trends. Vegetation communities with a native canopy component comprised 32 percent of the total area encompassed by cuckoo territories (Table 6) and 48 percent of the woody riparian vegetation found within territories (Figure 17). Forty-five percent of the area encompassed by cuckoo territories in 2019 (68 percent of the vegetated areas) contained a canopy component and 22 percent of the total area (32 percent of vegetated areas) contained an understory-only component (Table 6, Figure 17). Exotic canopy-dominated habitat comprised approximately four percent of the area encompassed by cuckoo territories and six percent of the woody vegetation found within territories. Native species were present in 55 percent of the total area encompassed by cuckoo territories, exotic species were present in 36 percent of the total area encompassed by cuckoo territories and no woody classification was found in 33 percent of the total area encompassed by cuckoo territories (Table 6).

Territories were composed of 19 percent open water or marsh and 14 percent uplands or open areas (Table 6), which demonstrates the relative importance of these features in landscapes that YBCU select for breeding.

Table 6.—Territory composition by major habitat type of 2019 YBCU breeding territories (n =75)

Major Plant Community Type	Area of Habitat Type* (ha)	Total Percentage of Territory
Native Canopy/Native Understory	34.5	6.5%
Native Canopy/Exotic Understory	30.3	5.7%
Native Canopy/Mixed Understory	79.4	15.0%
Exotic Canopy/Native Understory	5.3	1.0%
Exotic Canopy/Exotic Understory	0.3	0.1%
Exotic Canopy/Mixed Understory	5.4	1.0%
Mixed Canopy/Native Understory	12.6	2.4%
Mixed Canopy/Exotic Understory	12.1	2.3%
Mixed Canopy/Mixed Understory	18.2	3.4%
Native Canopy – No Understory	25.9	4.9%
Exotic Canopy – No Understory	9.3	1.8%
Mixed Canopy – No Understory	5.9	1.1%
Native Understory – No Canopy	24.2	4.6%
Exotic Understory – No Canopy	49.9	9.4%
Mixed Understory – No Canopy	40.6	7.7%
Open areas (Open, Roads, Meadows)	50.7	9.5%
Open water/marsh	100.0	18.9%
Uplands/Private Property†	25.2	4.7%
TOTAL	**529.7**	**100.0%**

*Area based on 150 m radius circle (approximately 7.1 ha) surrounding delineated territory center.
†Unmapped

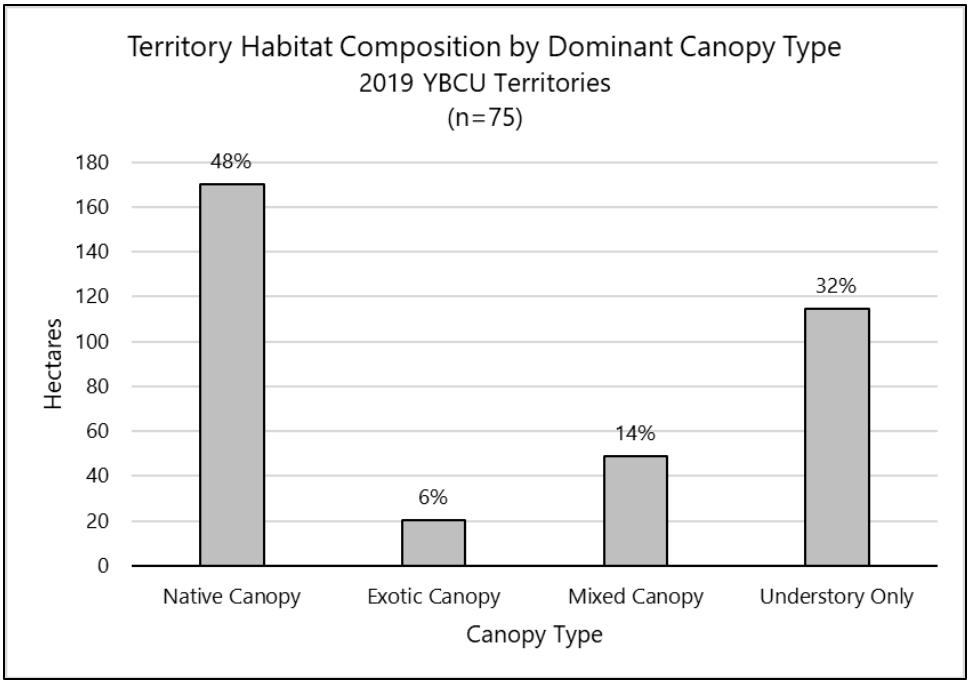


Figure 17.—Composition of woody riparian vegetation within 2019 YBCU territories. Only vegetated areas (353.8 ha) were used to determine relative percentages displayed above the columns.

Discussion

The YBCU has declined in abundance throughout the Western U.S. due largely to habitat loss and degradation. Although the Western YBCU DPS was listed as threatened under the Federal Endangered Species Act in 2014 (USFWS 2014b), historical data shows that the species was once relatively common along the Rio Grande (Bailey 1928).

Presence/Absence Surveys

Surveys conducted by Reclamation over the past 14 years have documented a persistent population of YBCUs within the Middle Rio Grande (Table 7). Unfortunately, it is difficult to directly compare the annual survey results prior to 2009 to those after 2009 since the survey effort (i.e. number of surveys) and study area varied.

The number of individual surveys per site conducted during each breeding season increased from three to four in 2009. This increased survey effort was initiated due to the high number of detections in the third/final survey from the Middle Rio Grande during the 2006 and 2007 seasons. Adding a fourth survey reduced uncertainty regarding the peak of the breeding season and the number of resident YBCUs. A minimum of four surveys is currently necessary to meet the survey requirements outlined in Halterman et al. (2016).

The geographic extent of the surveys also increased over time from 32 river miles in 2006 to 64 in 2007 and 2008, 90.5 in 2009, and 129 between 2014 and 2018. The surveyed area shrank to 79 river miles in 2019, when no surveys were conducted in the Belen or Sevilleta Reaches. Since 2009, the majority of changes in the survey area have occurred in the Belen Reach, allowing direct annual comparisons among all other reaches. Subtle increases (<1.5 river miles) in the extent of surveys within the San Marcial Reach have also occurred over the past several years, but only within Elephant Butte Reservoir where developing habitat has become suitable as the reservoir pool receded and additional survey areas were warranted.

Although changes occurred in some parts of the survey area, the results from 2009 through 2019 presented below are relatively consistent and comparable. The number of YBCU detections and breeding territories show marked variability from year to year (Figure 18). The San Marcial Reach, and in particular Elephant Butte Reservoir, continue to provide the greatest abundance of high-quality cuckoo habitat, and subsequently support the greatest density of cuckoos within the study area (Table 7, Figures 19 and 20). In 2019, neither the Belen nor the Sevilleta/La Joya reaches were surveyed. However, since 2015, detections have ranged from 12 to 54 and territory numbers from 4 to 12, with most occurring in the Belen reach. In 2019, detections and territories decreased in the San Acacia reach, similar to what was observed in this reach during 2015 and 2016. Results in the southernmost reaches (i.e. Escondida to San Marcial) have been relatively consistent between 2015 and 2019, with the Elephant Butte Reservoir sites of the San Marcial reach containing the majority of detections and territories (Table 7).

Table 7.—Number of YBCU detections and territories by river reach from 2006 to 2019

YBCU Detections/Territories Delineated by River Reach									
	Belen*	**Sevilleta/ La Joya**	**San Acacia**	**Escondida**	**Bosque del Apache**	**Tiffany**	**San Marcial**	**Total**	**Elephant Butte Reservoir****
2006	n/s	n/s	n/s	n/s	n/s	10/6	106/38	116/44	76/28
2007	n/s	n/s	n/s	3/2	22/13	12/4	222/52	259/71	182/36
2008	n/s	n/s	n/s	19/10	35/14	7/3	299/60	360/87	252/45
2009	1/0	4/2	8/1	29/9	47/11	10/3	257/69	356/95	211/56
2010	3/0	1/0	3/0	6/2	14/3	2/0	249/70	278/75	222/64
2011	16/4	6/2	6/1	15/3	17/4	4/1	202/58	266/73	159/46
2012	44/15	36/12	19/4	68/21	36/10	10/2	202/57	415/121	177/49
2013	20/6	19/6	20/5	80/23	29/8	4/1	219/70	391/119	189/60
2014	24/5	9/2	15/4	27/7	34/12	2/0	190/61	301/91	161/49
2015	39/10	18/5	27/8	62/16	40/12	2/0	215/59	403/110	210/57
2016	54/12	32/10	23/8	58/16	32/11	9/0	220/59	428/116	210/57
2017	34/4	12/4	50/13	44/11	43/10	2/0	227/56	412/98	214/54
2018	51/10	31/10	47/14	55/10	46/13	0/0	193/49	423/106	186/47
2019	n/s	n/s	29/8	50/11	59/14	0/0	190/42	328/75	186/41

* In 2014 an additional 35.5 river miles were added to the Belen Reach.
**Elephant Butte Reservoir is a subset of San Marcial Reach
n/s = not surveyed

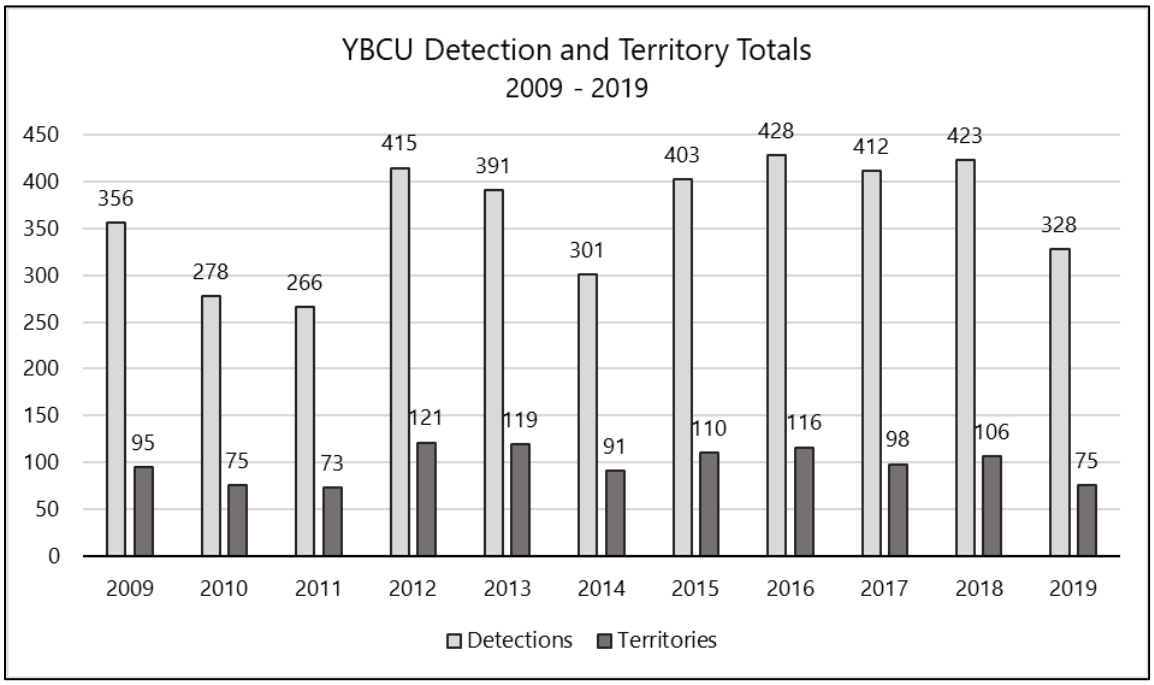


Figure 18.—YBCU detection and territory summary 2009 to 2019. Note: 2019 surveys only included 5 of the 7 reaches.

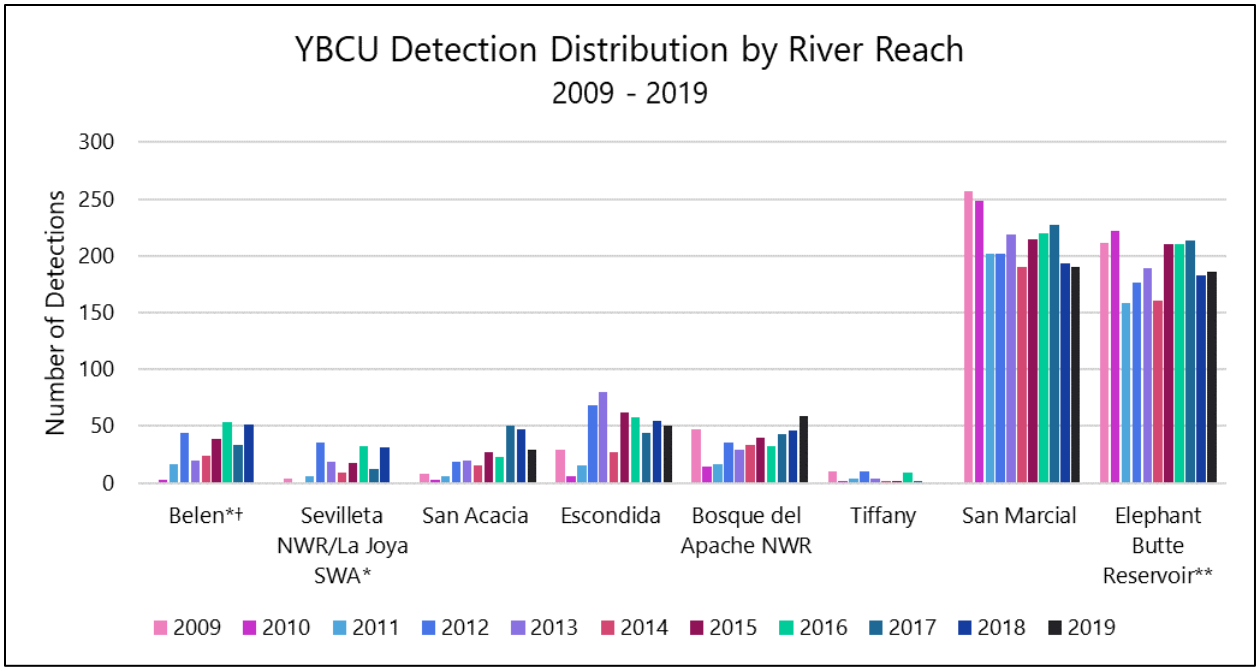


Figure 19.—BCU detections 2009 through 2019.

†Additional survey area was added in 2014.

*Belen and Sevilleta/La Joya Reaches not surveyed in 2019.

**Elephant Butte Reservoir is a subset of San Marcial.

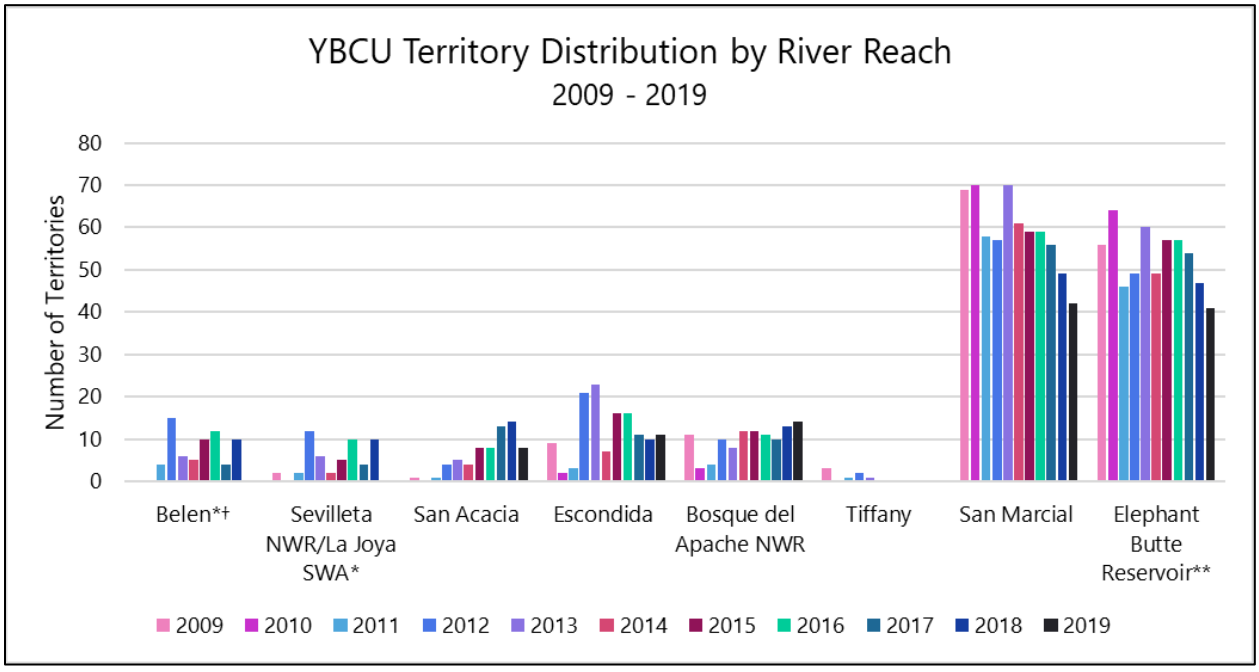


Figure 20.—YBCU Territories 2009 to 2019.

†Additional survey area was added in 2014.

*Belen and Sevilleta/La Joya Reaches not surveyed in 2019.

**Elephant Butte Reservoir is a subset of San Marcial.

Although annual fluctuations in detections and territory numbers have occurred over the past fourteen years, the Middle Rio Grande's total YBCU population appears to be generally stable and the population in the northern reaches has gradually increased overall (Table 7, Figure 20). However, detections within the entire 2019 study area have decreased by 7 percent from 2009 to 2019 (n=351 to n=328), and territories have decreased by 19 percent (n=93 to n=75). The lowest number of detections/territories in the study period occurred in 2011 (266 detections and 73 territories), followed by a dramatic increase in 2012 when detections and territories increased more than 56 and 66 percent respectively. Detections and territories have decreased in the San Marcial Reach for the last three years, which may be a result of habitat loss from changing hydrological conditions and the Tiffany Fire. Observed annual fluctuations may be normal occurrences and have been reported in other populations within the western U.S. (Finch 1992). The following is a discussion of the population trends within each study reach.

The Belen Reach (Figures 21 and 22) was surveyed for the first time in 2009 from Hwy 60 to the confluence of the Rio Puerco (about 4 river miles; Figure 22), and not surveyed in 2019. Starting in 2014, this reach was extended 35.5 river miles north to the south boundary of the Isleta Pueblo (Figure 21). The original area had a low number of detections and no breeding territories in 2009, 2010 and 2014. In 2018, the original area had ten detections and three territories. The number of detections and territories in the Belen Reach as a whole has increased fairly consistently since 2009. In 2018, the Belen reach had 10 territories and 41 detections (Table 7). As in previous years, these detections were largely concentrated in the southern end of the reach. Future surveys will indicate whether YBCU detections will continue to gradually increase and become more evenly distributed throughout the entire Belen Reach, or remain concentrated within the downstream portion of this reach.

The Sevilleta/La Joya Reach (Figure 23) was also surveyed for the first time in 2009, and not surveyed in 2019. From 2009 through 2011, only a handful of detections and territories were found within this reach (Table 7). However, a dramatic increase in both detections and territories was documented in 2012. From 2011 to 2012 the number of detections and associated territories increased from 6 to 36, and from 2 to 12, respectively. However, detections and territories again declined in the subsequent two years to a low of nine detections and two territories in 2014. Numbers increased in 2015 and 2016, decreased in 2017, and then increased in 2018 to 41 detections and 10 territories (the highest number of detections documented in this reach). The emerging pattern appears to be one of frequent natural annual variability in population size.

The San Acacia Reach (Figure 24) was also surveyed for the first time in 2009; surveys documented eight detections and one territory that year (Table 7). Detections remained low in the subsequent two years but as with the reaches discussed above, 2012 results showed a sizeable increase in both detections (19) and territories (4) (Figures 19 and 20). Unlike the Belen and Sevilleta/La Joya Reaches in which detections again declined after 2012, the San Acacia cuckoo population remained relatively stable with detection and territory numbers predominately increasing from 2012 to 2018 (Table 7). In 2017 the San Acacia Reach supported the highest number of detections (50) and in 2018 the highest number of territories (14) north of San Marcial, far surpassing previous years' numbers in the reach. However, in 2019 territory numbers matched 2015 and 2016 (8) despite similar hydrological conditions to 2017. One nest was found in this reach in 2019 and successfully fledged young. Future studies will indicate whether this fluctuating cycle will continue, or if a possible long-term population increase is possible.

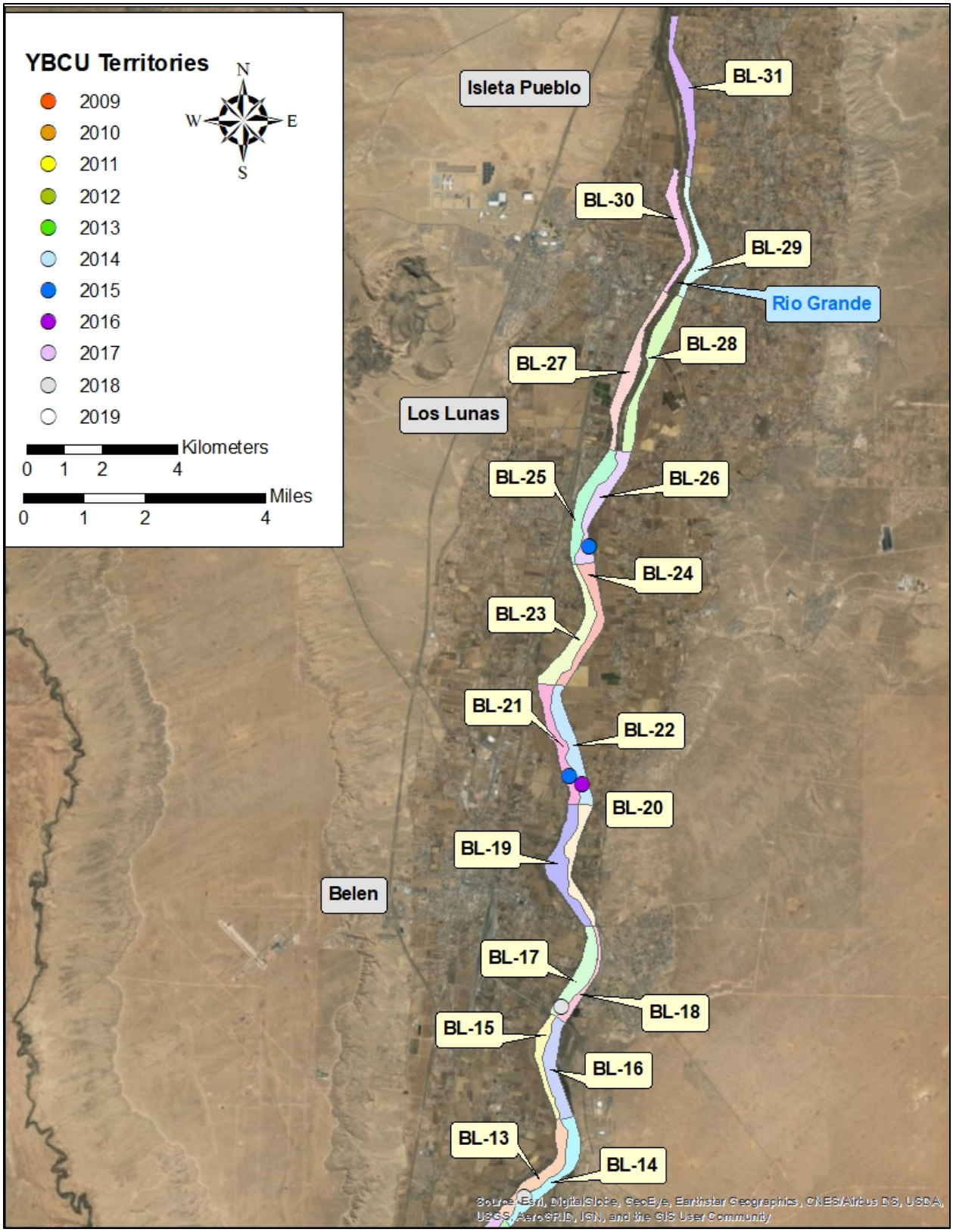


Figure 21.—Overview of YBCU territories from 2009 through 2018 (last year of surveys) within the Belen Reach (map 1 of 2).

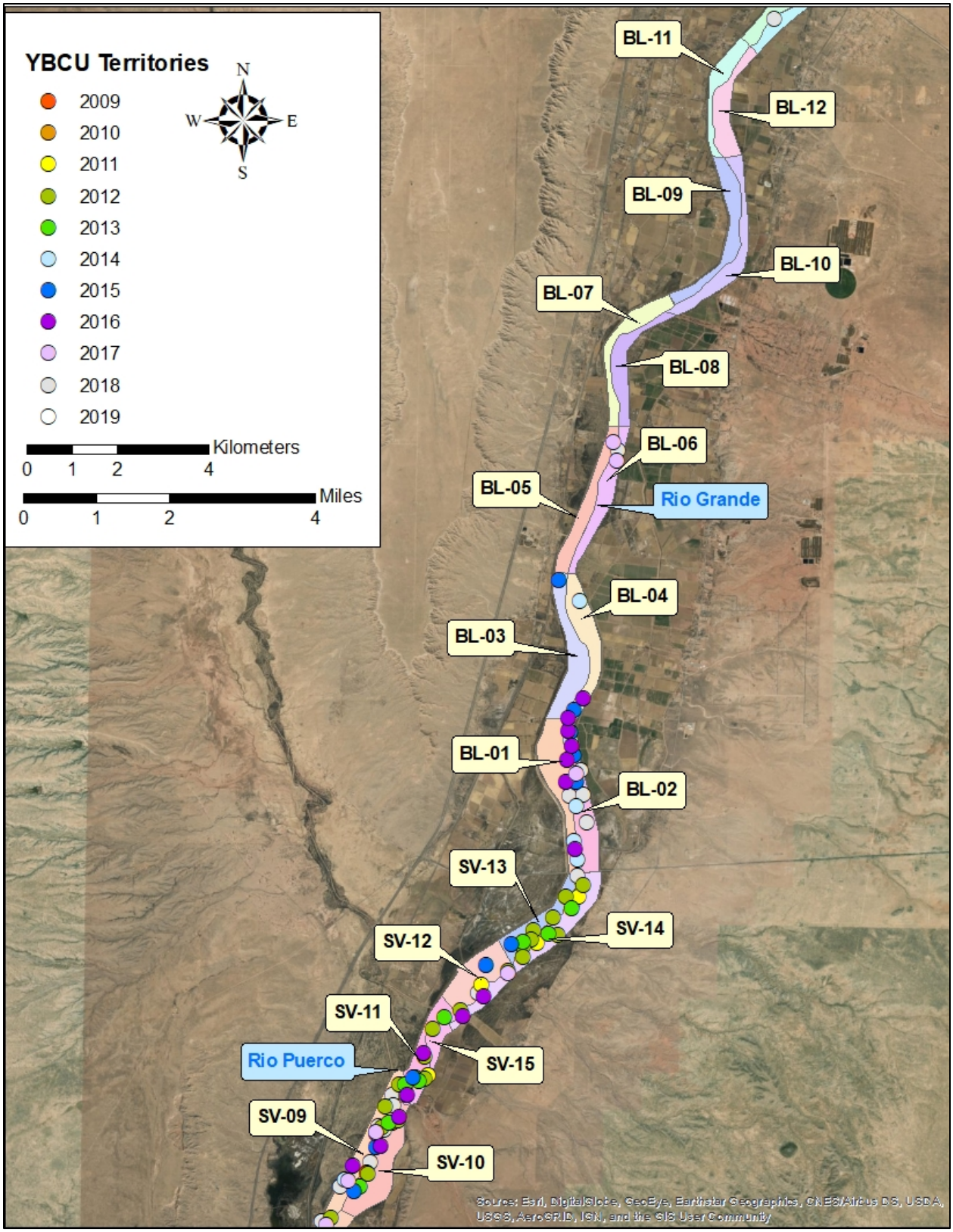


Figure 22.—Overview of YBCU territories from 2009 through 2018 (last year of surveys) within the Belen Reach (map 2 of 2).

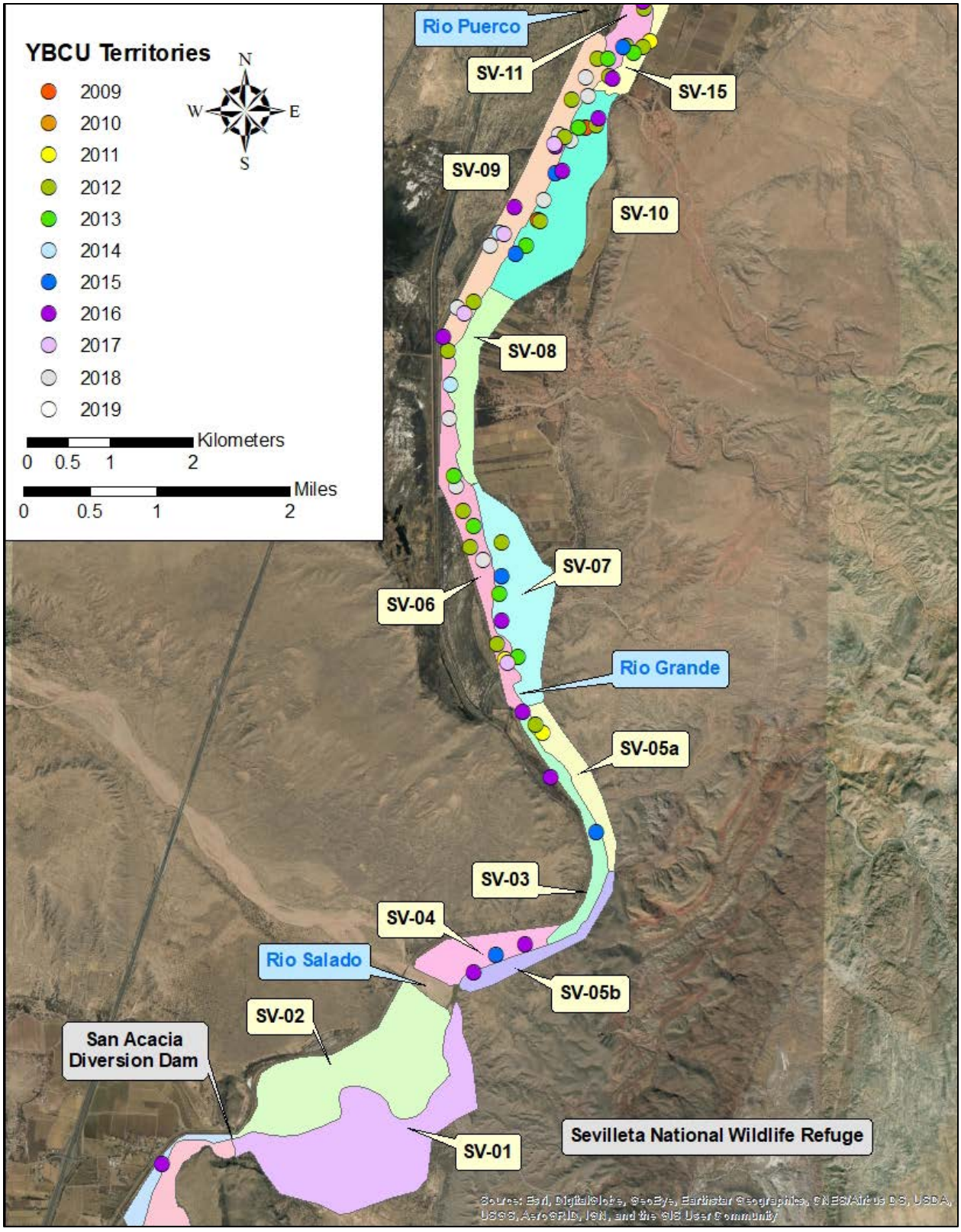


Figure 23.—Overview of YBCU territories from 2009 through 2018 (last year of surveys) of the Sevilleta and La Joya Reach.

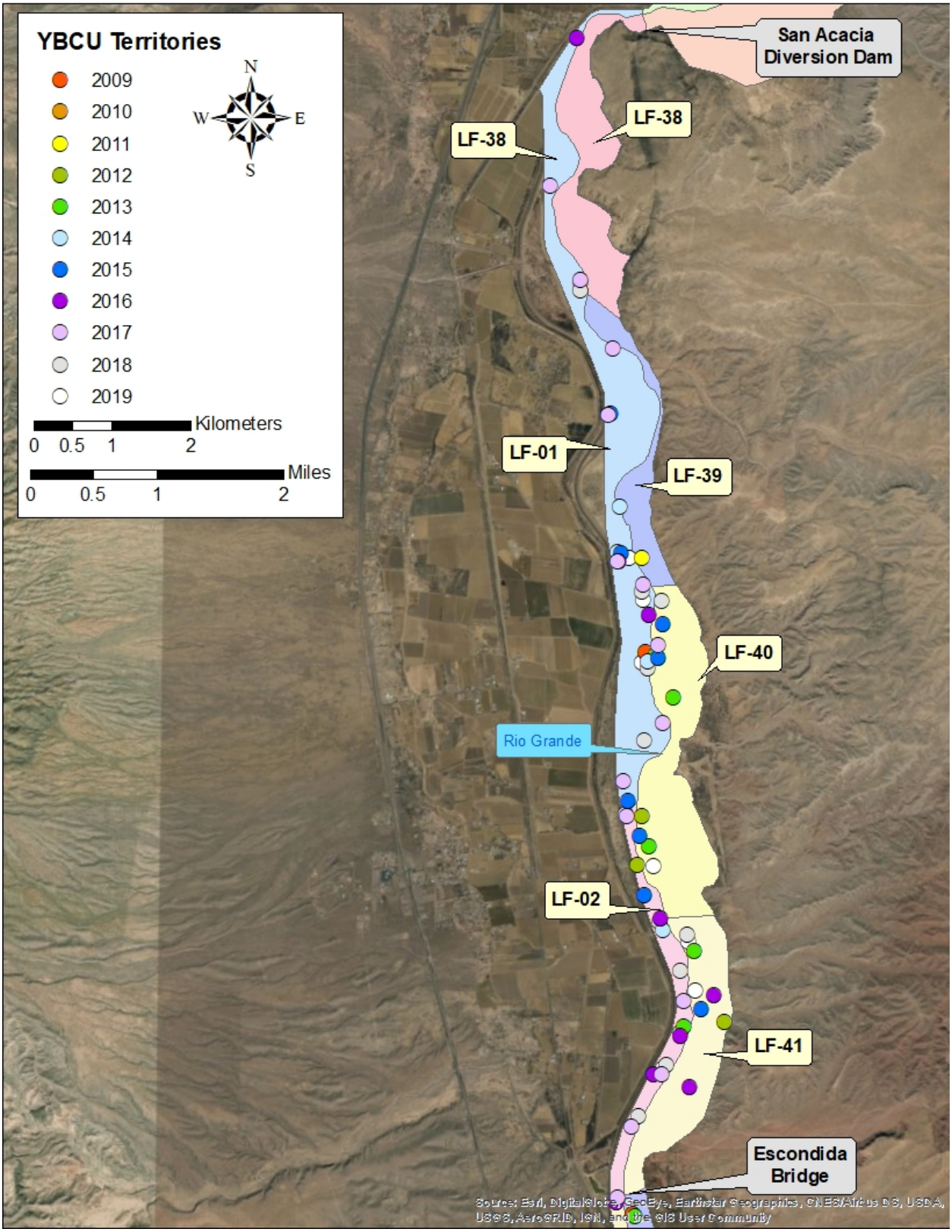


Figure 24.—Overview of YBCU territories from 2009 through 2019 of the San Acacia Reach.

The Escondida Reach (Figure 25) has been surveyed in its entirety or in part since 2007. In 2009, surveys documented 29 detections, representing 9 breeding territories (Table 7). During the 2010 and 2011 survey seasons, detections and associated territories declined markedly (Table 7, Figures 19 and 20). However, the 2012 totals of 68 detections and 21 territories was a two-fold increase over the 2009 totals in both detections and territories. The Escondida Reach was one of only two reaches that experienced population increases during 2013, with 80 detections comprising approximately 23 territories were documented. Interestingly, a large decline was observed from 2013 to 2014; detections decreased approximately 66 percent (n=27) and territories decreased 70 percent (n=7; Table 7). The number of detections and territories in this reach increased again in 2015 and while they have continued to fluctuate in subsequent years, the numbers of detections and territories consistently remain higher than those recorded in 2009. During the radio telemetry study, two nests were found in this reach in 2019, but only one was successful.

The Escondida Fire burned approximately 212 ha in the northern end of this reach in June 2016. No cuckoo territories were documented prior to the fire in this area and, in 2016 and 2017, a few territories were documented in close proximity to the fire boundary. This suggests that this fire had minimal negative impact on the cuckoo population in this area.

The Bosque del Apache Reach (limited to the active floodplain as opposed to the entirety of the refuge) has also been surveyed since 2007 (Figure 26). In 2009, a total of 47 detections comprising 11 territories were documented within the Bosque del Apache Reach. Like the Escondida Reach, detections and associated territories dramatically declined in 2010 and 2011, only to recover in 2012 (Table 7, Figures 19 and 20). In both 2014 and 2015, 12 territories were delineated, 11 territories were delineated in 2016, and 10 territories were delineated in 2017. In 2018, 13 territories were identified, the highest number since 2009. Unlike the upstream reaches, the Bosque del Apache Reach is subject to frequent overbank flooding during normal river flows due to an aggraded river channel and associated sediment plug. The first significant overbank flooding since 2010 occurred in 2017, after several years of extremely low river flows occurring during the breeding season. More persistent and deeper overbank flooding was observed in 2019 as a result of high river flow, the reformation of a sediment plug and vegetation clearing in the river realignment channel. It is interesting to note that the vast majority of cuckoo detections and territories have been found adjacent to or upstream of the sediment plug, which is located in the river channel along survey sites BA-05, BA-06, BA-09, and BA-10 (Figure 26). It is likely that the higher groundwater levels typically associated with sediment plugs has increased the overall density of native and mixed canopy vegetation, and perhaps increased prey densities. Additionally, sites further south were cleared of salt cedar several years ago and portions were burned in the Tiffany Fire.

The Tiffany Reach (Figure 27) has been surveyed annually since 2006 and cuckoo detections have remained low over the survey period (Table 7). Indeed, no breeding territories have been documented in this reach since 2013 (Figures 19 and 20). This reach was only surveyed during survey period one in 2017, after which much of the reach was severely burned in the Tiffany Fire. In both 2018 and 2019, only site LF-26 was surveyed due to a lack of suitable habitat as a result of the fire. Habitat within this reach will continue to be assessed annually to determine if surveys are warranted.

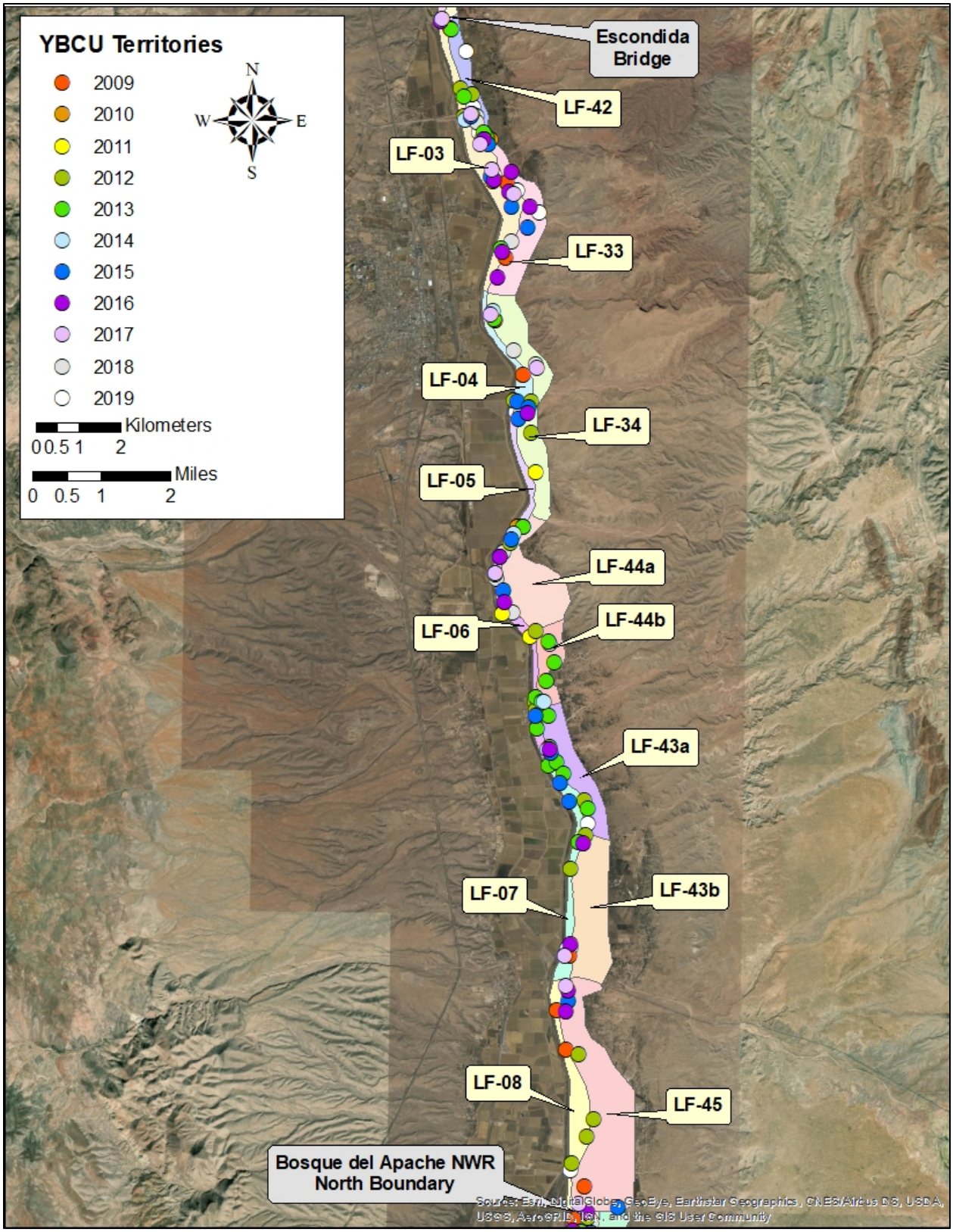


Figure 25.—Overview of YBCU territories from 2009 through 2019 within the Escondida Reach.

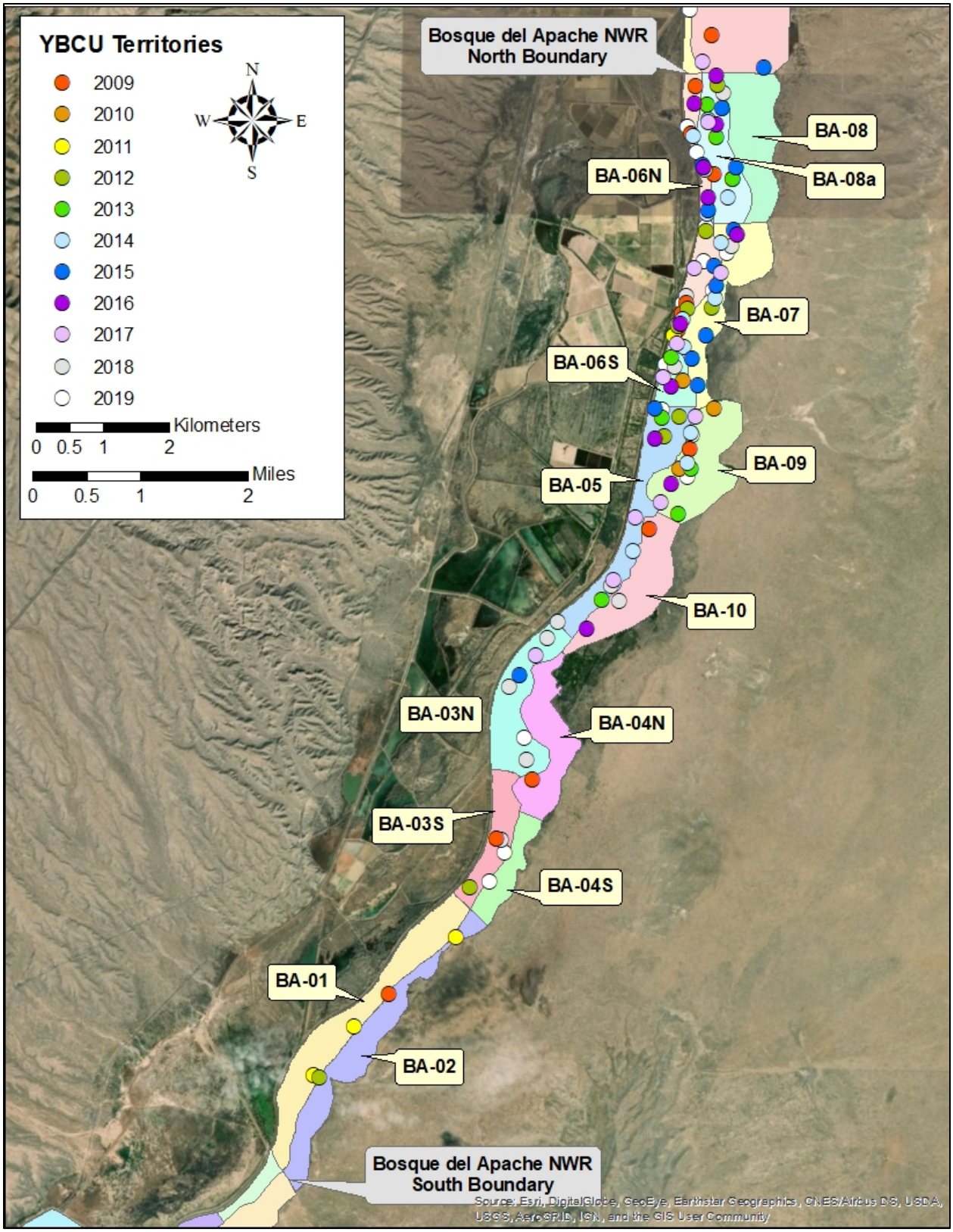


Figure 26.—Overview of YBCU territories from 2009 through 2019 within the Bosque del Apache Reach.

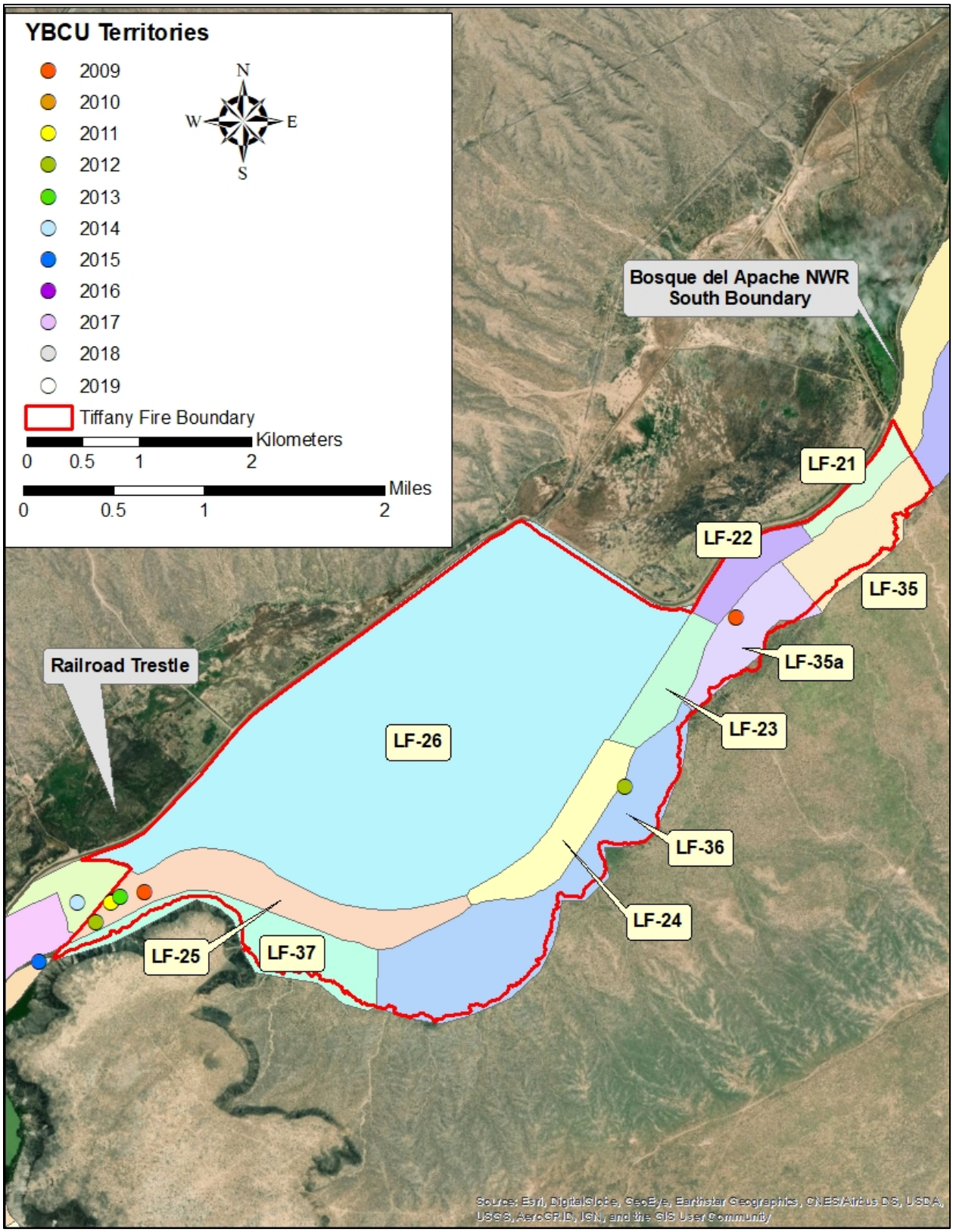


Figure 27.—Overview of YBCU territories from 2009 through 2019 within the Tiffany Reach.

The San Marcial Reach (Figures 28 through 30) has the largest population of YBCUs in the study area, yielding more than 59 percent of all cuckoo detections and territories between 2009 and 2019 (Table 7). This reach is also the largest of all survey reaches encompassing 6,752 ha (4,977 ha post-Tiffany fire) of riparian habitat (Table 2). In 2009, there were 257 detections, comprising an estimated 69 territories. While there was some annual fluctuation in the number of detections and territories from 2009 to 2019, overall numbers remained relatively high with an average of 215 detections and 59 territories per year (Table 7). Twenty-six percent fewer detections and 39 percent fewer territories were recorded in 2019 than in 2009, but 2008 to 2010 saw the largest population sizes in this reach in the last decade. Nevertheless, territories have been decreasing over the last three years, with 2019 having the fewest estimated territories of the eleven-year study period. Regardless of annual fluctuations and the recent decline in population size, the San Marcial Reach has consistently supported the highest numbers of cuckoos and breeding territories in the study area, and possibly within the species' range.

In 2019, the exposed reservoir pool of Elephant Butte (Figures 28 to 30) encompassed approximately 98 percent of all YBCU detections and territories found within the San Marcial Reach. This subset of the San Marcial Reach also contained 56.7 percent of all cuckoo detections and 54.7 percent of all territories found in the entire Middle Rio Grande Study Area in 2019 (Table 4). A significant proportion of the San Marcial/Elephant Butte detections occur within The Narrows (Figure 30), where the riparian vegetation lies in narrow sections bordered by steep canyon walls. Although there are no definitive conclusions as to why the birds preferentially settle in The Narrows, perhaps easy access to the uplands provides greater foraging opportunities, and/or the relatively dense mid-aged stands of Goodding's willow provide ideal nesting habitat. Also, in 2019 a significant number of detections were recorded in sites closest to the reservoir pool that were underwater for a large portion of the 2019 breeding season. Additionally, there is a stable population at the confluence of the LFCC outfall and the Rio Grande (Figure 29).

A total of 5 YBCU nests have been found within the San Marcial Reach, all of them within the exposed reservoir pool of Elephant Butte. Two nests in 2017 and three nests in 2018 were located and monitored. Nest success varied from 100 percent in 2017 to 67 percent in 2018. No nests were discovered in 2019 as cuckoos tagged in the radio telemetry study had territories centered outside of the San Marcial Reach.

Although prolonged drought conditions over the past several years have reduced the structure and density of younger age classes of vegetation within the San Marcial Reach, the more mature stands occupied by YBCUs do not appear to have been as heavily impacted. The deeper roots from mature overstory trees have been able to reach groundwater in order to sustain themselves. However, if drought persists and the depth to groundwater deepens, even the more mature canopy trees will likely suffer.

While the San Marcial Reach consistently contains the majority of detections and territories within the study area, annual survey results suggest that the distribution of breeding territories within the Rio Grande Basin can vary annually among reaches, likely influenced by the availability of preferred habitat, vegetation, and hydrological characteristics. It is also possible that the population variability may be linked to the variation in prey abundance (USFWS 2014a, USFWS 2014b).

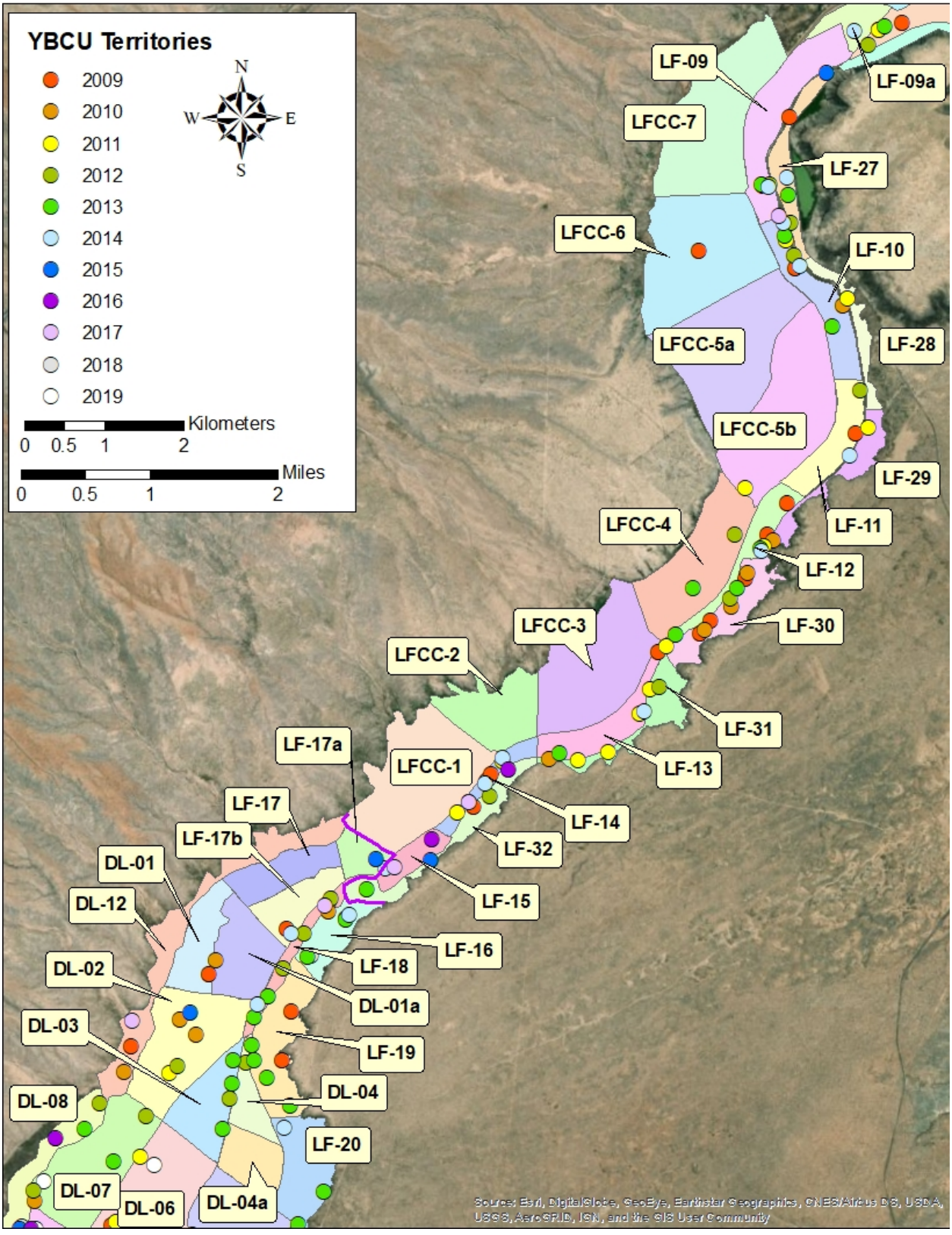


Figure 28.—Overview of YBCU territories from 2009 through 2019 within the San Marcial Reach (map 1 of 3). North boundary of Elephant Butte subset outlined in purple.

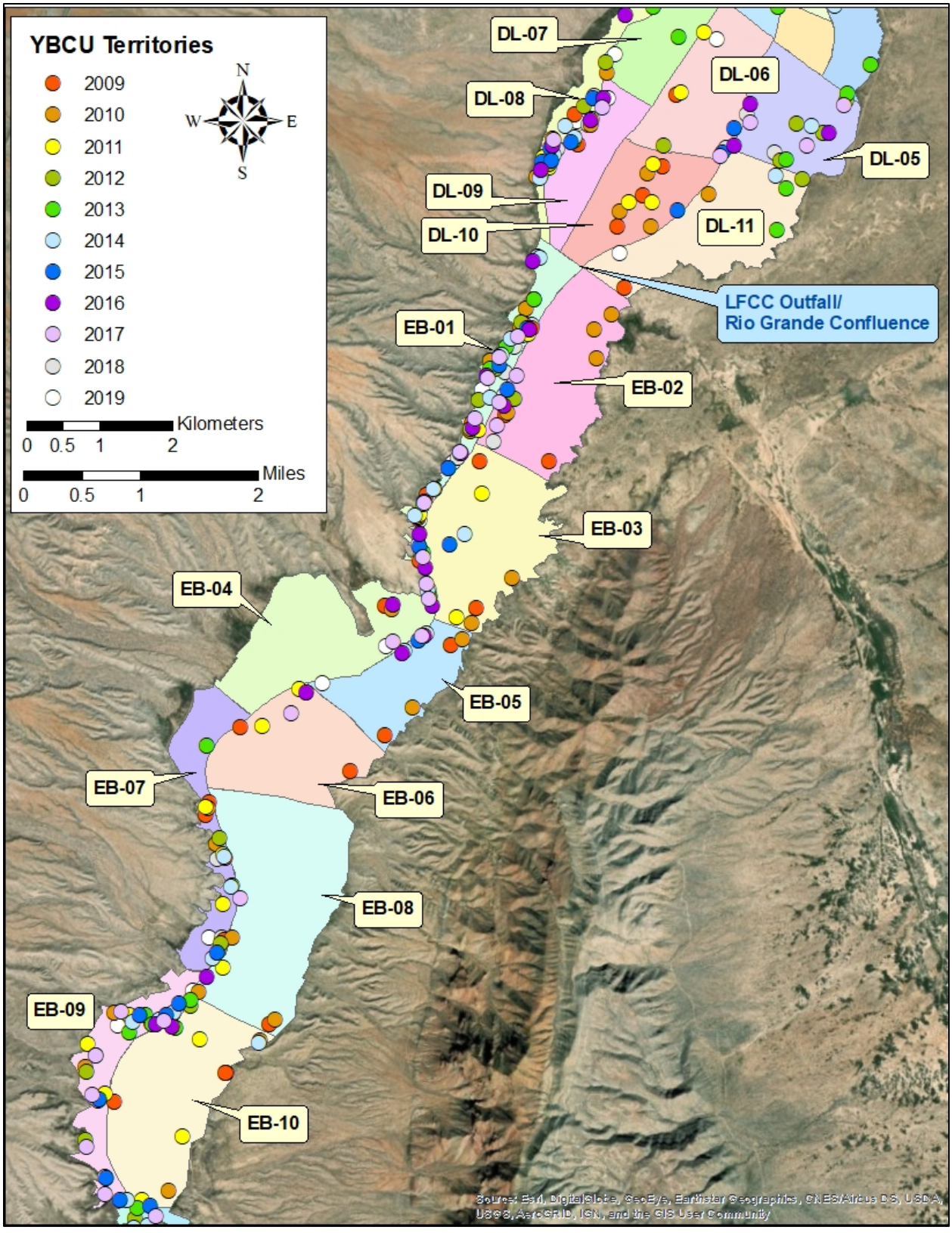


Figure 29.—Overview of YBCU territories from 2009 through 2019 within the San Marcial Reach (map 2 of 3).

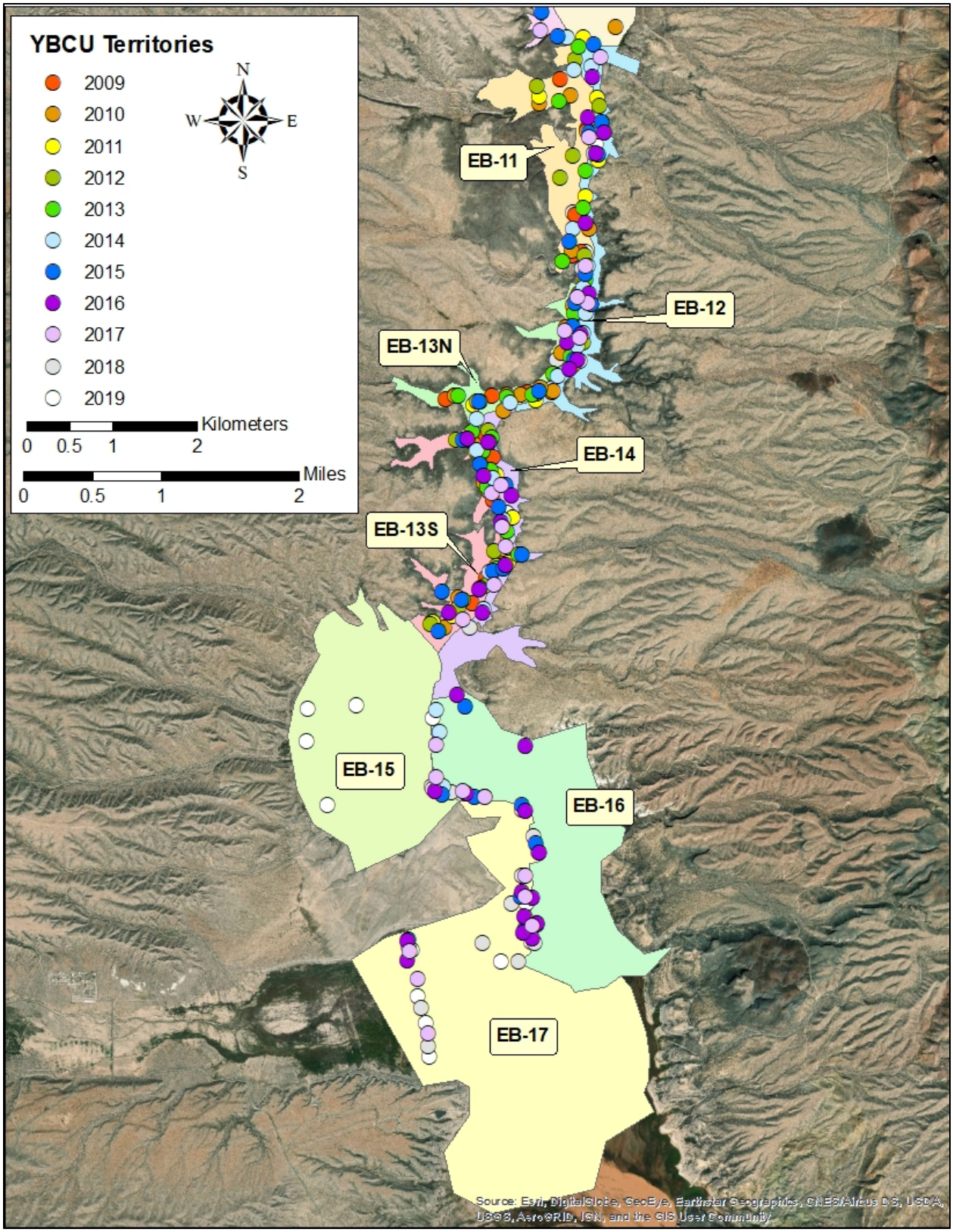


Figure 30.—Overview of YBCU territories from 2009 through 2019 within the San Marcial Reach (map 3 of 3).

YBCU Response to Playback Surveys

From 2007 to 2019, 1,293 of the 4,622 total YBCU detections (28 percent) were made prior to broadcasting the "kowlp" recording (Table 8). This result emphasizes the need for a pre-broadcast listening period when conducting surveys. Seventy-five percent of all detections (n = 4,622) were made during the pre-broadcast period and the first two playback broadcasts combined, suggesting that cuckoos are relatively vocal and responsive to the broadcast recording during the breeding season (Table 8). From 2007 through 2019, 39 percent of all solicited responses (n = 3,329) occurred following the first "kowlp" playback (Table 8). By the third playback, 84 percent of the solicited detections were made, suggesting that most YBCUs are responsive to the "kowlp" playbacks.

Table 8.—Summary of 2007 through 2019 YBCU responses after playback number

Percentage of Detections After Playback Number							
	Detections prior to playback	Detections using playback	Playback number				
			1	2	3	4	5
2007 (n=259)	89	170	45% (n=76)	26% (n=45)	17% (n=28)	5% (n=9)	7% (n=12)
2008 (n= 360)	120	240	46% (n=110)	26% (n=63)	12% (n=29)	9% (n=21)	7% (n=17)
2009 (n=356)	127	229	47% (n=108)	24% (n=55)	20% (n=46)	5% (n=11)	4% (n=9)
2010 (n=278)	82	196	47% (n=92)	23% (n=45)	21% (n=42)	6% (n=11)	3% (n=6)
2011 (n=266)	87	179	32% (n=58)	27% (n=48)	17% (n=30)	10% (n=18)	14% (n=25)
2012 (n=415)	131	284	39% (n=110)	24% (n=69)	18% (n=52)	12% (n=35)	6% (n=18)
2013 (n=391)	117	274	36% (n=98)	19% (n=53)	20% (n=55)	10% (n=28)	15% (n=40)
2014 (n=301)	92	209	36% (n=75)	32% (n=67)	14% (n=30)	11% (n=22)	7% (n=15)
2015 (n=403)	98	305	46% (n=139)	25% (n=77)	14% (n=44)	10% (n=30)	5% (n=15)
2016 (n=428)	88	340	31% (n=106)	29% (n=97)	24% (n=83)	9% (n=32)	6% (n=22)
2017 (n=412)	73	339	34% (n=117)	25% (n=86)	22% (n=73)	11% (n=37)	8% (n=26)
2018 (n=425)	84	341	37% (n=128)	30% (n=101)	14% (n=49)	10% (n=33)	9% (n=30)
2019 (n=328)	105	223	39% (n=87)	35% (n=79)	13% (n=30)	9% (n=20)	3% (n=7)
TOTALS (n=4,622)	**1,293 (28% of Total)**	**3,329 (72% of Total)**	**39% (n=1304)**	**27% (n=885)**	**18% (n=591)**	**9% (n=307)**	**7% (n=242)**

In 2006, 33 percent of all detections were made during the third (and final) survey period, and in 2007, 41 percent of all detections were made during the third (and final) survey period (Table 9). Based on these results, the survey protocol was modified in 2008 to include a fourth survey period with the goal of detecting additional cuckoos. The survey results from most years indicate a notable decrease in the number of detections during the fourth survey, suggesting that the YBCUs had either vacated the breeding grounds or were less vocal near the end of the breeding season and indicating that a fifth survey extending into late August is not warranted. Additional assessments in 2014 and 2018 of the effectiveness of the YBCU surveys found that four surveys identified 98 percent of occupied sites and detected 85 percent of individual cuckoos. Adding a fifth survey only increased the percent of occupied sites being identified to 99 percent and the percent of individual cuckoos being identified to 90 percent (Dillion et al. 2019).

Table 9.—Summary of 2006 through 2019 YBCU detections per survey period

	Percentage of Detections Observed per Survey Period			
	Survey 1	**Survey 2**	**Survey 3**	**Survey 4**
2006 (n=116)	33% (n=39)	33% (n=39)	33% (n=38)	Not Conducted
2007 (n=259)	30% (n=78)	29% (n=74)	41% (n=107)	Not Conducted
2008 (n=360)	18% (n=66)	27% (n=98)	36% (n=129)	19%[(1)] (n=67)
2009 (n=356)	24% (n=86)	30% (n=107)	26% (n=92)	20% (n=71)
2010 (n=278)	19% (n=52)	30% (n=83)	30% (n=83)	21% (n=60)
2011 (n=266)	15% (n=39)	27% (n=72)	29% (n=77)	29% (n=78)
2012 (n=415)	17% (n=72)	29% (n=120)	30% (n=126)	23% (n=97)
2013 (n=391)	21% (n=84)	24% (n=92)	32% (n=127)	23% (n=88)
2014 (n=301)	27% (n=82)	25% (n=75)	29% (n=86)	19% (n=58)
2015 (n=403)	24% (n=98)	28% (n=113)	36% (n=146)	11% (n=46)
2016 (n=428)	18% (n=76)	28% (n=119)	29% (n=123)	26% (n=110)
2017 (n=412)	21% (n=87)	23% (n=95)	31% (n=127)	25% (n=103)
2018 (n=425)	22% (n=94)	27% (n=114)	25% (n=107)	26% (n=110)
2019 (n=328)	21% (n=69)	29% (n=95)	27% (n=87)	23% (n=77)
2009-2017[(2)] (n=3,675)	**21% (n=770)**	**27% (n=990)**	**30% (n=1094)**	**22% (n=821)**

[(1)] Only a portion of the study area was surveyed four times.

[(2)] Total detections per survey period were compiled only for the 2009 to 2017 period due to the consistency of effort and scope during these years.

Habitat Utilization

Data from the 2009 to 2019 surveys were analyzed in two ways to explore YBCU habitat utilization: the detection distribution method and the territory composition method. Ninety-three percent of all detections (n = 4,001) between 2009 and 2019 were located within areas of woody riparian vegetation and were included in the following analysis.

Detection Distribution Model

The majority of YBCU detected within areas of woody riparian vegetation (non-habitat excluded) between 2009 and 2019 (54 percent) were in vegetation communities with a native-dominated canopy (Figures 31 and 32). A little over 4 percent of all detections within woody habitat types from 2009-2019 (n = 3,727) were in vegetation communities comprised of exotic canopy with an understory component (Figure 31), and approximately 16 percent of detections were in vegetation with mixed native and exotic canopy cover and an understory component. This distribution of detections among native, mixed, and exotic canopy types further suggests that cuckoos prefer breeding habitat with native-dominated canopy vegetation

However, only 7 percent of all detections were in vegetation communities with a native canopy and no understory, while 47 percent were found in vegetation comprised of a native canopy with an understory component. This suggests vegetation communities with both native overstory and understory structure are an important component of YBCU breeding habitat. As previously stated in this report, a dense understory, comprised of exotic saltcedar, Russian olive or native vegetation (e.g. *Salix* spp.) also appears to be a prerequisite for territory establishment (Sechrist et al. 2009). Indeed, the USFWS (2013) describes cuckoo habitat as "low to moderate elevation riparian woodlands" containing "willows of fairly old growth, often mixed with Fremont cottonwoods" over a tangled understory. Although Figure 31 suggests that "Native Canopy/Mixed Understory" (20 percent of detections) were utilized to a greater extent than "Native Canopy/Native Understory" (12 percent of detections), the difference was not likely due to selection, but rather due to differences in habitat availability. Within the 2016 vegetation map, native canopy over mixed understory comprised 1,575 ha (10 percent) of the available habitat, while only 526 ha (3 percent of surveyed habitat) was native canopy over native understory. While recent data suggest that YBCU do preferentially select native-dominated vegetation in both the overstory and understory, canopy composition and the presence of understory appear to be the driving factors in predicting occupancy

Although 25 percent of YBCUs from 2009-2019 (n = 3,727) were detected in understory vegetation types that lacked a canopy component (Figures 31 and 32), these results should not be misinterpreted to represent suitable nesting habitat. It is likely that during the course of conducting presence/absence surveys cuckoos would be found foraging in understory areas for prey or may have moved to these areas in response to the surveyor's broadcast of the "kowlp" call prior to responding and being documented by the surveyor. While not providing suitable breeding habitat, these habitat types might provide other value to YBCUs and may indicate a preference for landscape heterogeneity. Another consideration is that exotic understory alone comprised 32 percent of woody riparian vegetation in 2016, demonstrating the high availability of this habitat type across the landscape, and increasing the likelihood that YBCU's may be detected there.

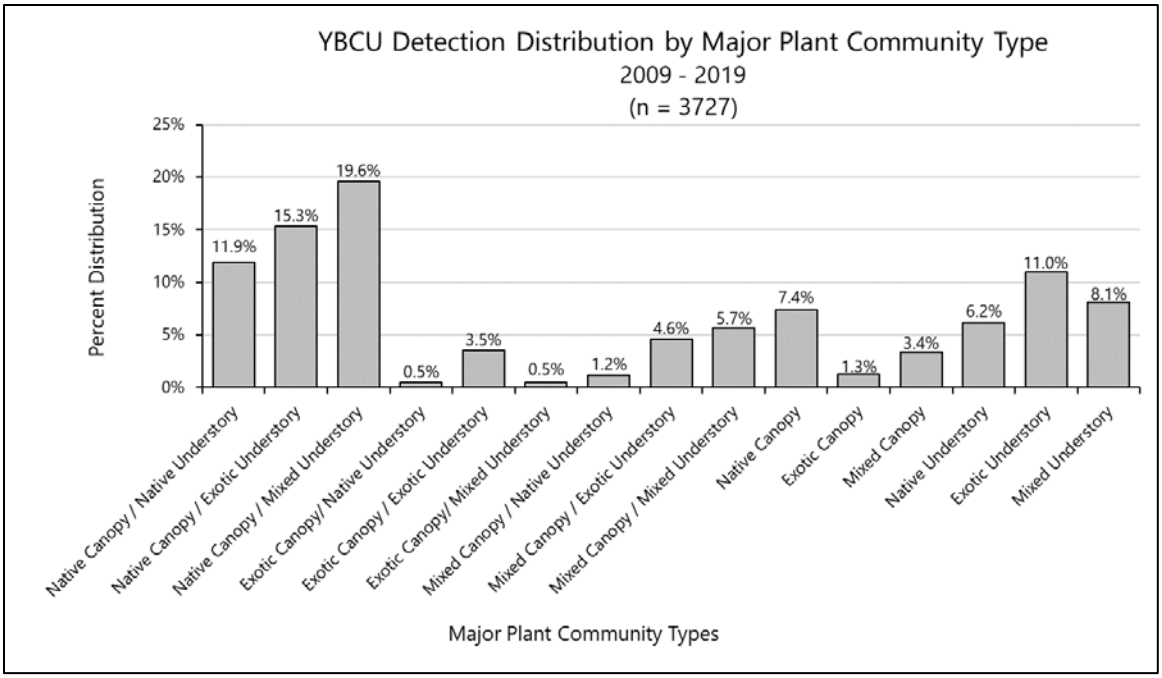


Figure 31.—Percentage of YBCU detections within major Middle Rio Grande habitat types – 2009 to 2019.

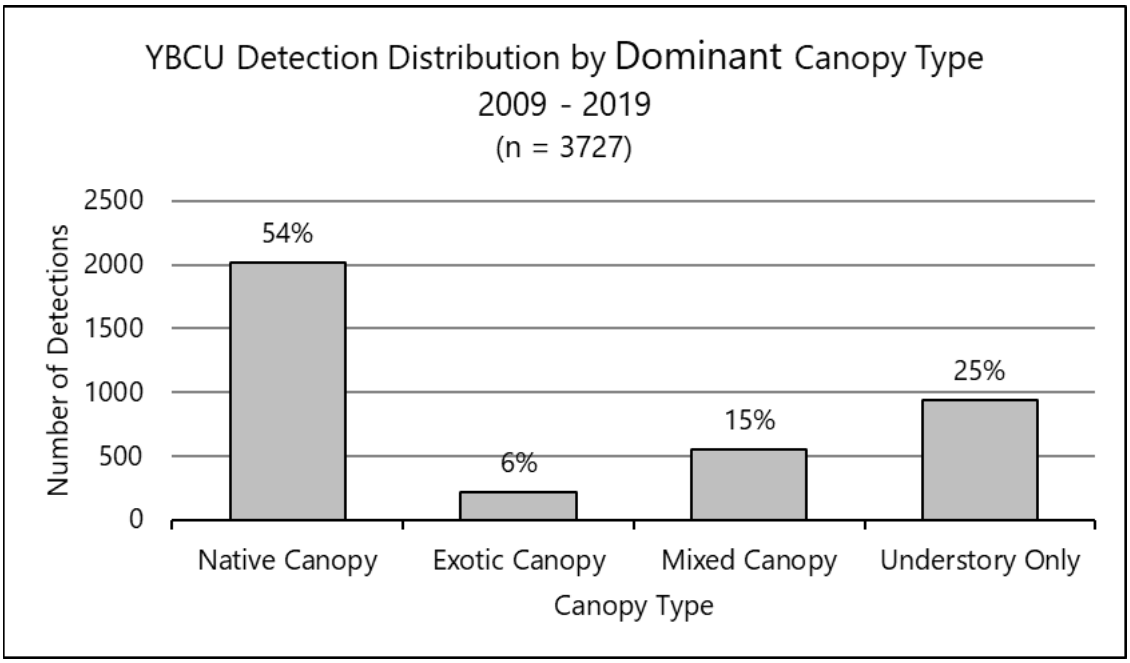


Figure 32.—YBCU detections and associated dominant canopy types in the Middle Rio Grande 2009 through 2019. Only vegetated areas were used to determine relative percentages displayed above columns.

Understory habitat is typically abundant throughout most riparian systems, particularly those with a dynamic flow regime, or in areas where fluctuating reservoir levels may allow for earlier successional stands to develop. Based on 2009 to 2019 detection results, 88 percent of all YBCU detections (n = 3,727) were located in riparian habitat with an understory component (Figure 31). Perhaps the most important role of understory structure in YBCU breeding habitat is that, when found in conjunction with a native canopy component, it can provide foraging habitat and nest concealment.

Territory Composition Model

The second method for analyzing habitat utilization was conducted by summing the area of each major habitat type within the core use area (~7.1 ha surrounding estimated territory point) for each delineated cuckoo territory. Results were similar to those of the individual detection method. When considering all data from 2009 to 2019 (Figure 33), 68 percent of cuckoos' core use area contained a canopy component. Native canopy-dominated habitats comprised 47 percent of the cuckoo's core use area, while exotic and mixed canopy dominated areas accounted for approximately 21 percent (Figures 33 and 34). This is likely due to the cuckoos' affinity for the particular vertical vegetative structure provided by riparian canopy vegetation (USFWS 2014a). However, it is important to note that only ten percent of the canopy-dominated areas did not support an understory component (Figure 34), highlighting the importance of understory structure in cuckoo habitat selection. Understory without a canopy component comprised approximately one third (32 percent) of the total core use area from 2009 to 2019 (Figures 33 and 34). This understory habitat may be utilized for foraging by YBCUs, but not for nesting. Although exotic understory alone comprised nearly half of the total 32 percent, that is most likely due to the preponderance of this habitat type in proximity to breeding habitat and not specifically indicating a foraging habitat preference.

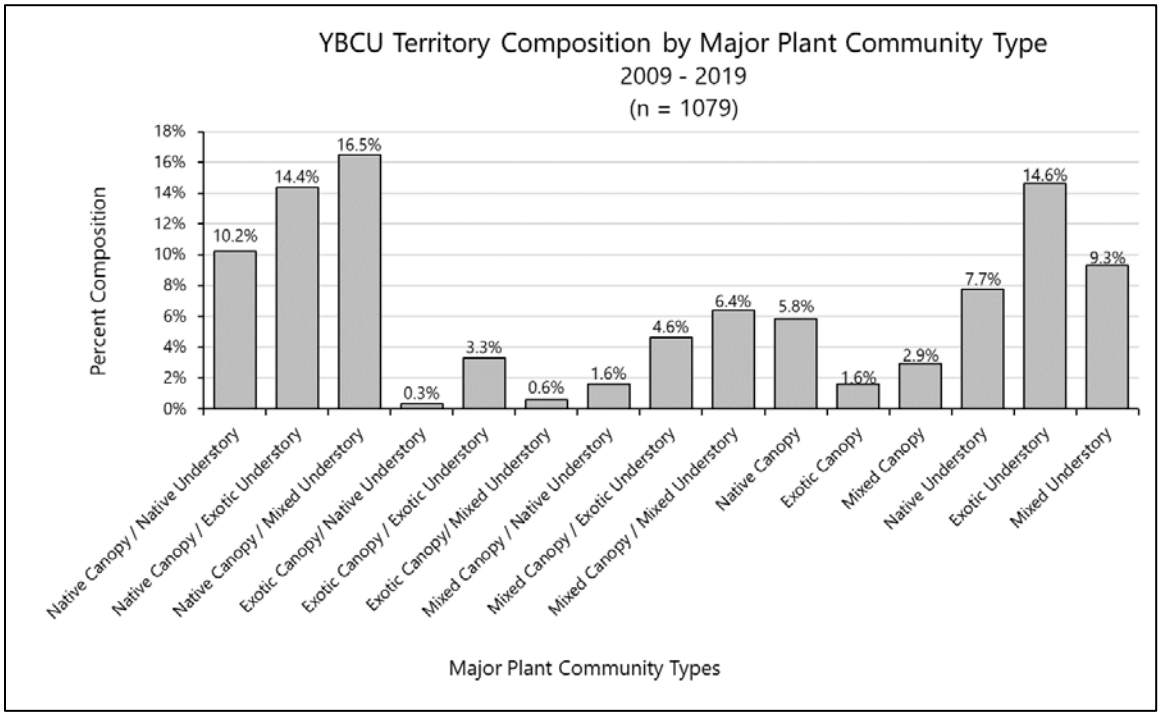


Figure 33.—Percent composition, by major habitat type, of YBCU territories – 2009 through 2019. Includes only vegetated areas; non-habitat excluded.

Furthermore, 90 percent of the vegetated areas encompassed by cuckoo territories from 2009 to 2019 contained understory vegetation structure (Figure 34). Further studies are warranted to compare the distribution and abundance of breeding YBCUs with habitat availability, habitat preference, nest success, and productivity.

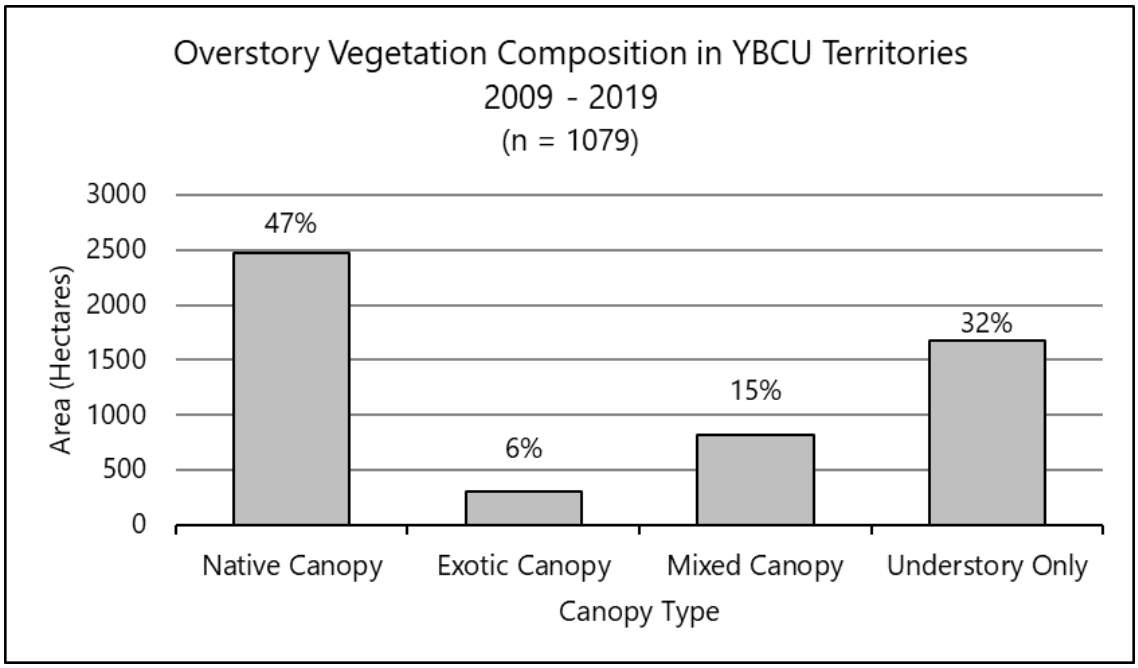


Figure 34.—Area encompassed by dominant canopy types within YBCU territories – 2009 through 2019. Non-habitat areas excluded. Only vegetated areas were used to determine relative percentages displayed above columns.

YBCU Distribution within Elephant Butte Reservoir

Following the recession of Elephant Butte Reservoir water levels between 1995 and 2004 (Figure 35), several large stands of native Goodding's willow-dominated habitat became established. In the upstream portion of Elephant Butte Reservoir, this habitat is maintained on the west side of the floodplain by flows from the LFCC and is typically flooded during wet years. Habitat within the southern portion of the exposed reservoir continues to develop and is likely to support an increasing number of cuckoos in the near future. Conversely, habitat in the upper portion of the exposed reservoir associated with both the Rio Grande and the LFCC outfall has begun to decline in quality due to either a reduced groundwater table, extended flooding or maturation into decadent stands. These areas become less attractive to nesting YBCUs as they are converted to either cattail marsh or dry, sparse saltcedar.

During the summer of 2013, Elephant Butte Reservoir dropped to its lowest elevation since 1972. The reservoir pool elevation of 4,286 feet in July 2013 was approximately 120 vertical feet below the spillway, and nearly 1.9 million acre-feet from full capacity. However, multiple heavy rain events and

winter flows in late 2013 and early 2014 increased reservoir levels to an elevation of 4,330 feet in May 2014. The increased levels allowed flooding to occur in the newly established and thriving habitat in the area closest to the reservoir (Figure 36).

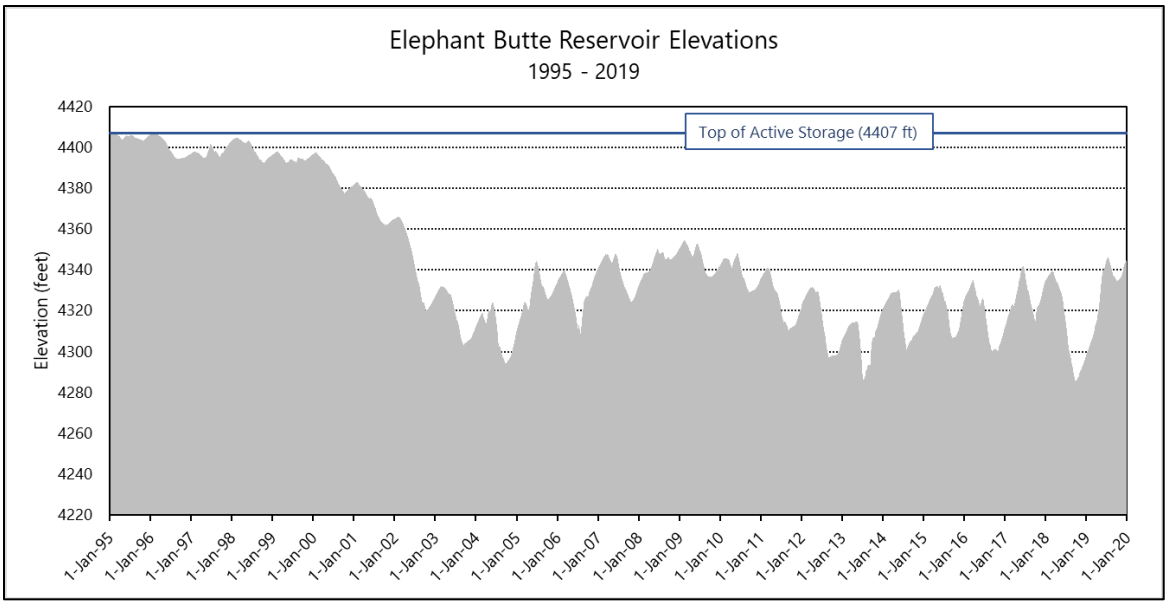


Figure 35.—Elephant Butte Reservoir elevations 1995 to 2019.

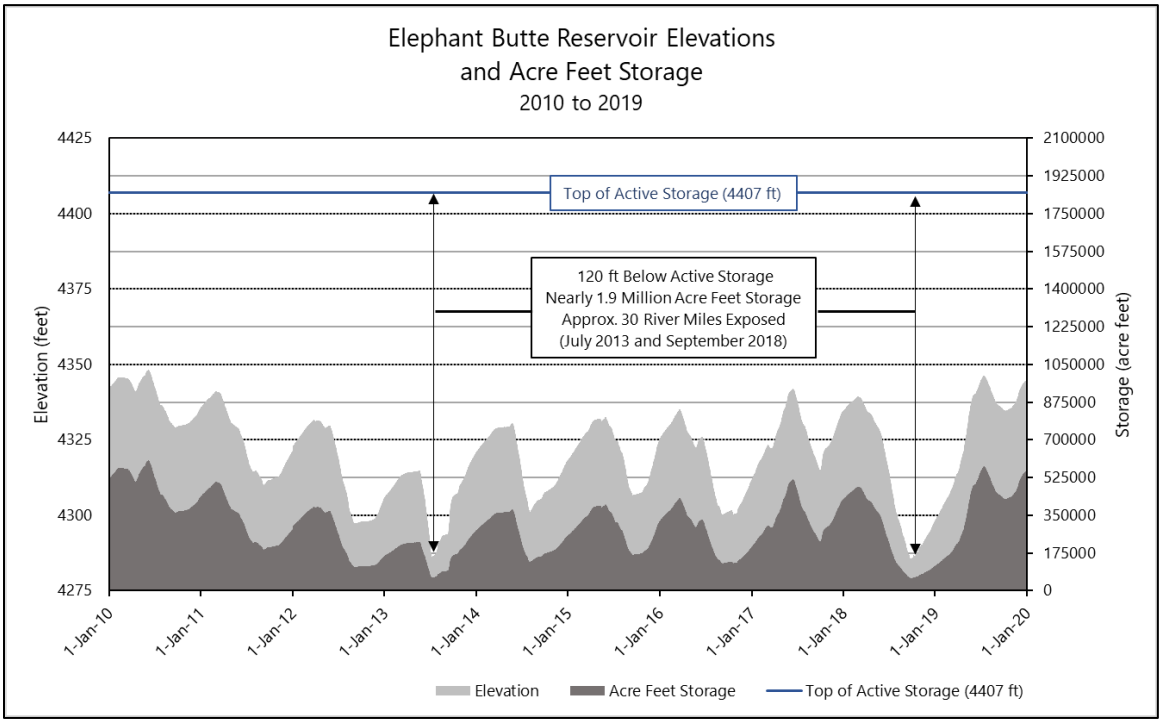


Figure 36.—Elephant Butte Reservoir elevations and storage 2010 to 2019.

Reservoir elevation patterns were similar from 2014 to 2016. Fluctuations became more irregular between 2017 and 2019, when peak reservoir levels were higher and longer in duration than any year since 2010. Additionally, in September 2018, the reservoir level again dropped to 4,286 feet (the same low level documented in July 2013). At this elevation, the receded pool exposed 12,950 ha spread over 30 river miles of floodplain (Figure 36). As in any exposed reservoir situation, the potential threat of habitat inundation persists – although a 2009 hydrologic runoff model predicted greater than 18 consecutive years of average inflow into Elephant Butte Reservoir would have been needed to reach spillway elevations (W. Treers pers. comm. 2009).

Figures 37 and 38 illustrate the elevational distribution of cuckoos within Elephant Butte Reservoir from 2007 to 2019. The greatest density of cuckoos within Elephant Butte Reservoir over the past eleven years has been in the five-foot elevational range of 4,355 feet to 4,360 feet (Figure 37). This five-foot contour range corresponds to The Narrows and the area immediately upstream of The Narrows in the vicinity of site EB-09 (Figure 39). However, over the last few years there has been a notable increase in detections at higher elevations, and a shift towards a more equal elevational distribution of detections in general. Although there were no cuckoo detections below 4,345 feet prior to 2013, the number of detections below this elevation has gradually but steadily increased in subsequent years as habitat has developed in the southern end of the Elephant Butte Reservoir pool. Over 19 percent of all detections since 2014 (n = 1,167) were found below 4,345 feet. Indeed, detections below 4,345 feet have increased from 25 percent in 2018 to 32 percent in 2019 (Figure 38). There has also been an increase in detections at higher elevations, in the vicinity of EB-01 through EB-05. A continuation of this shift in detections across reservoir pool elevations is likely to occur as habitat suitability continues to increase in these areas.

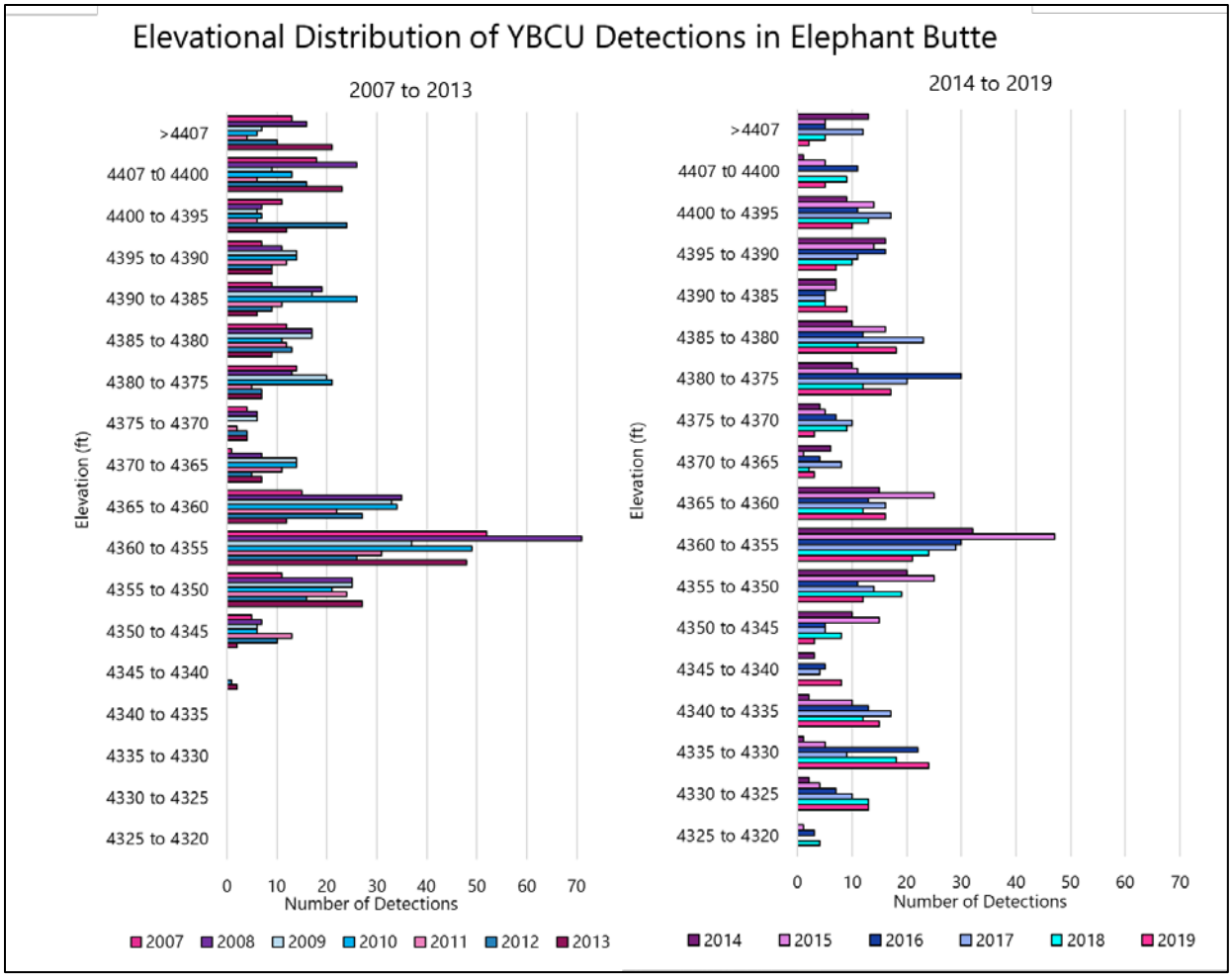


Figure 37.—Elevational distribution of YBCU detections 2007 to 2019.

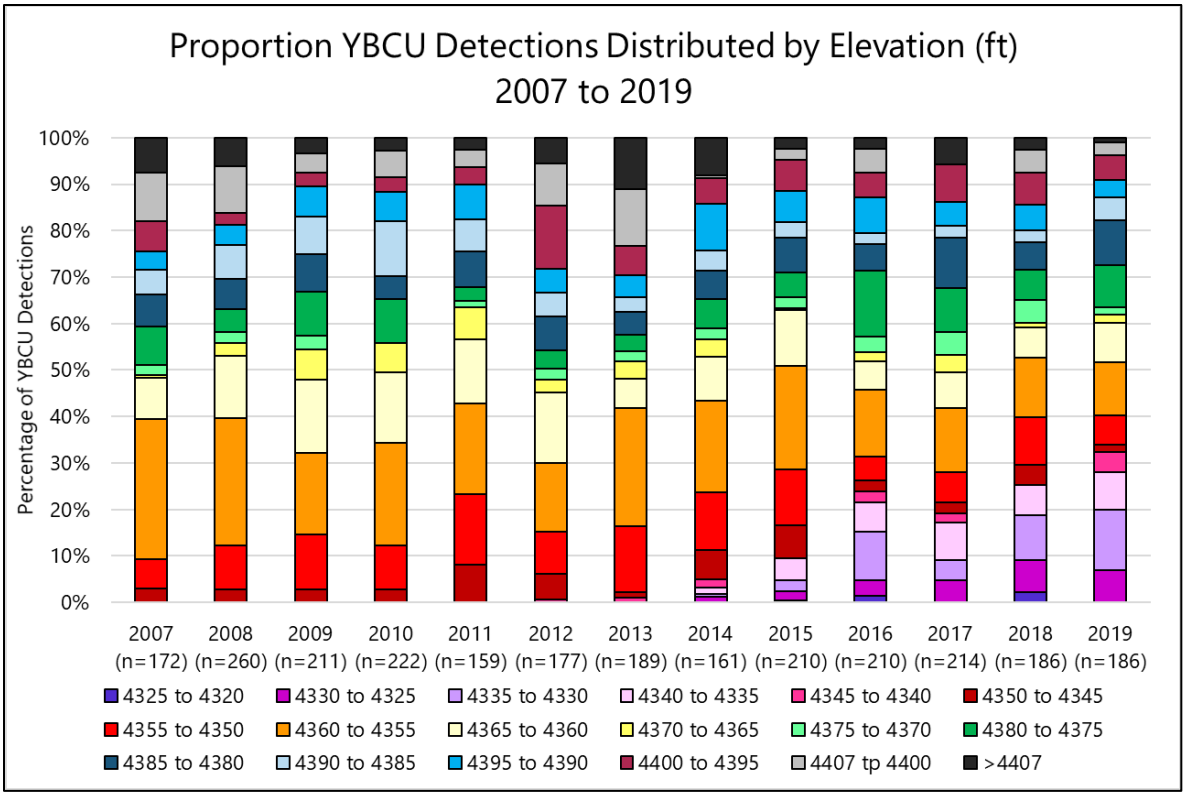


Figure 38.—Proportion of YBCU detections distributed by elevational gradations 2007 to 2019.

If the elevation of Elephant Butte Reservoir was to rise over 4,360 feet in elevation, adverse effects to current YBCU habitat could be expected. During the 2019 survey season, the average elevation of water within the reservoir was 4,344 feet (minimum 4,341 feet, maximum was 4,346) which is higher than the location of almost one third of the 2019 detections. Despite the loss or adverse effects to currently occupied habitat that could be expected under prolonged elevated reservoir levels, upstream areas will likely benefit as a result of flooding and a higher groundwater level.

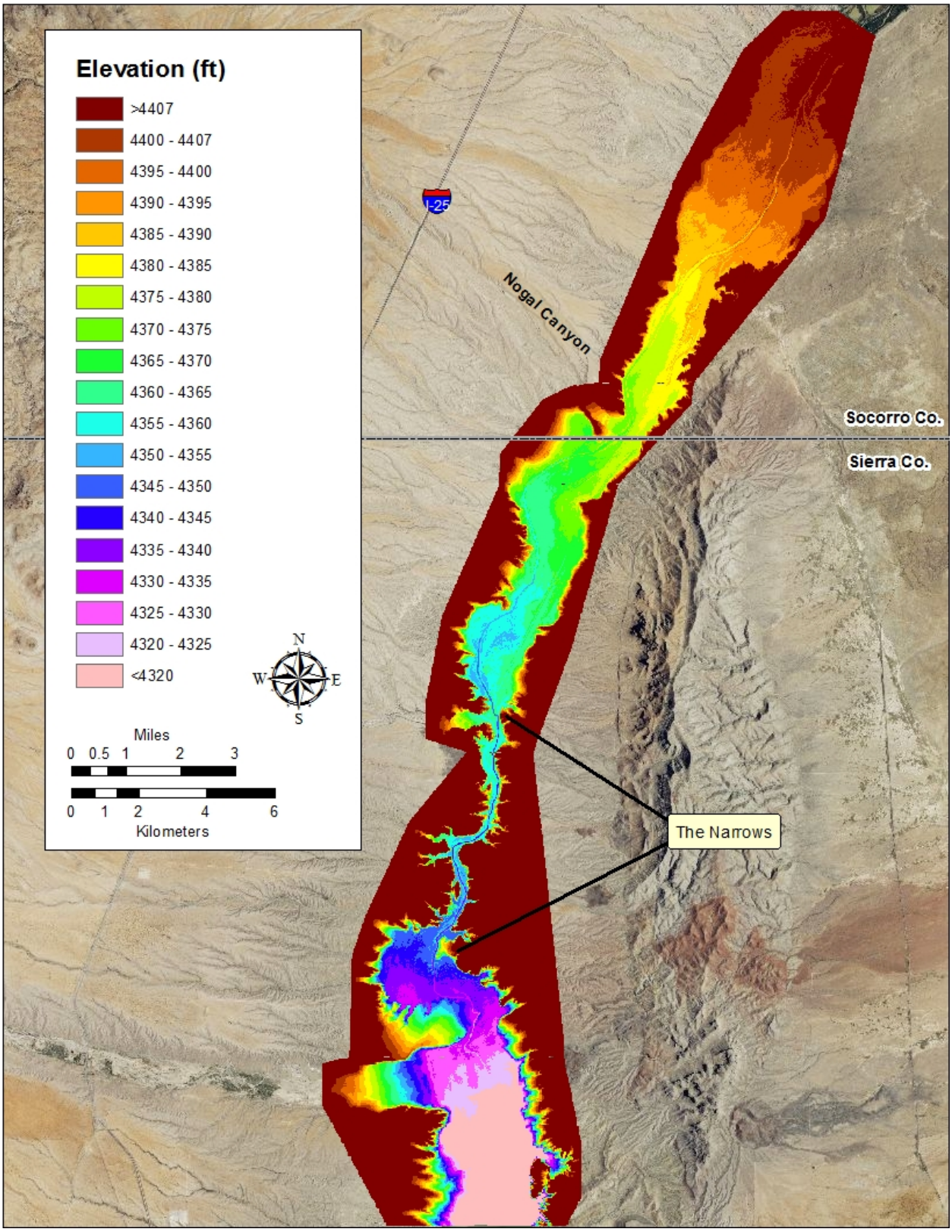


Figure 39.—Elephant Butte Reservoir surface elevation intervals.

Conclusions

The YBCU survey effort has been constant in the Middle Rio Grande for the past eleven years, documenting a sizeable population of cuckoos, with the exception of the area in the Belen Reach added in 2014 and the absence of surveys in two reaches in 2019. By far, the greatest extent of suitable habitat and the largest breeding population of cuckoos is in the San Marcial Reach and, in particular, the exposed pool of Elephant Butte Reservoir. Since 2009, sites within the reservoir have produced 53 percent of all cuckoo detections within the Middle Rio Grande Study Area. This population of 53 territories, on average, fluctuates annually but appears to be well established and likely serves as a source population for sites upstream and downstream within the Rio Grande. Other reaches have not been nearly as productive, but small patches of habitat have developed in several reaches that are attractive to breeding cuckoos, and consistently retain smaller populations. Future surveys will be a valuable monitoring tool for the Middle Rio Grande cuckoo population as a whole and will help determine if these habitat patches and populations expand or change their distribution.

Recommendations

1. Continue annual surveys within currently occupied sites and suitable habitat.

2. Continue and expand the telemetry program in order to determine whether vegetation changes are affecting home range characteristics, to locate nests, and to determine and quantify critical nest site selection variables.

3. Monitor any documented cuckoo nests in order to gain insight into nesting variables. YBCU nests are rarely found without the use of radio-telemetry so there is currently minimal information about cuckoo productivity, nest success and site fidelity on the Rio Grande.

4. Update the GIS database with annual YBCU territory locations in order to monitor population trends based on detection and territory abundance.

5. Obtain current aerial photography and update vegetation maps to document changes and identify potential restoration opportunities when needed.

6. Quantify the existing habitat within the Middle Rio Grande to identify key habitat variables responsible for supporting a relatively large YBCU population.

7. Coordinate with other entities to determine the probability of response given the existing detection protocol.

8. Continue incorporating and testing various combinations of “kowlp”, “knocker”, and “coo” calls into the survey protocol and evaluating the detection probabilities of all combinations.

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